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EDITORIAL

PLANNING, INTERPRETATION AND PRESENTATION OF RESEARCH

Most of the material published in the *Philippine Agriculturist* consists of student theses, which present the results of studies on problems dealing with agriculture. The preparation of a thesis has come to be a very important part of the activity of the student at the College of Agriculture, and a properly presented piece of experimentation or research is a part of the requirement for graduation. The work upon which the thesis is based is done under the guidance of the teaching staff of the College, and much of the value of such work necessarily depends upon the amount and kind of supervision given by the adviser and critics. The aim should be constantly before the student as well as the adviser to raise the standard of work done on the thesis and to improve the method of presentation of the results.

The student working on a thesis problem may be regarded as a beginner or *apprentice* in scientific research or in the application of science to the art of agriculture. The precautions he should take and the methods he should use are similar to those employed by experienced workers in scientific investigation. In this connection it seems of value to quote from a recent article by Professor B. E. Livingston, one of the foremost workers in botanical research in America. [1]

While Dr. Livingston's article deals with only one phase of research, botanical, and is written for professional scientists and investigators, it contains many suggestions that should be of value in any

[1] Livingston, Burton Edward. Some responsibilities of botanical science. [Address of the chairman and vice-president of Section G-Botany, American Association for Advancement of Science, Baltimore, December, 1918.] Science N. S. **49**: 199-207. 1919.

line of research and that may profitably be given serious thought by even the beginner in scientific work. Dr. Livingston says in part:

(a) *The Planning of Research.*—It has seemed to me that the planning of scientific investigation deserves very much more attention than it generally receives. Not having any clear aims, we are apt to be misled to the erroneous idea that all sorts of research are of equal importance. Perhaps it is not any longer fashionable to tell students that the mere gathering of facts in *any* field constitutes valuable scientific work, but we surely have not passed far beyond the conception that a personal and capricious interest is a proper and respectable guide in the choosing of a problem and in determining how it is to be carried out. It often seems that each worker brings forward his contributions without any notion as to how they are to fit into the structure of the science as a whole. It is somewhat as though each of us brought what he happened to have and threw it on a large and heterogeneous pile, hoping that a rational structure might, by some unknown means, be builded therefrom. We seem to feel little or no responsibility in the building itself, we bring contributions that can not be used at present and we let the building operations stop at many points because we do not bring the materials that are immediately needed.

A well-selected problem does not always mean a well-planned investigation, however; and an opportune problem has often led to great waste of time and work simply because the method of attack was hurriedly decided upon. As you have surely observed, experimental and observational investigation, as it is published, frequently shows what almost seems to be a genius for omitting the needed experimental controls. Again, things that are of relatively small importance are often dwelt on with great care, while the most outstanding points are woefully neglected. Needs that should have been cared for in the preliminary plan are often not appreciated until the experimental or observational work is completed, when it is too late to mend matters.

I have been led to think that this condition of affairs is largely due to a still more or less prevalent and very insidious fallacy, to the effect that a scientific investigator can not hope to find out what he sets out to find out, but has to drift with winds and currents and gather in the observations and results that he happens to run across. It is sometimes the business of a pioneer explorer to work in this way, but I think we should hardly call that sort of work scientific research in the modern sense. Discoveries of *facts* may be made now and then by chance and intuition, but discoveries of *relations* (with which our science now mostly deals) are largely to be made by taking serious thought as to just what we need to do in order to find out just what we set about finding out.

You have been warned earlier in this address of the fact that I regard cooperation as the touchstone by which we may hope to cure, or at least alleviate, many of our scientific ills, and you will at once see that our selection of problems and our planning of projected investigations would be greatly improved if cooperation between competent thinkers were more in vogue. If every projected research involving considerable expenditure of money and energy might be submitted to several competent workers, with the request that they make suggestions, I have no doubt that much more valuable and feasible plans might result. It strikes one as a curious fact that scientific investigators wish to keep their work secret until it is finished (as they may fondly suppose), after which they are just as strong in their wish to present it to their colleagues. The results of investigation are frequently treated like Christmas gifts; they are planned and made in secret and handed to the recipients only after alterations are well-nigh impossible! And, finally, to complete the anomaly, the investigator is often sorely pained if his contribution proves to be very imperfect or even quite unacceptable! One wishes to ask why it would not be better to obtain the adverse criticism *before* the work was "finished," rather than to wait until after publication; the criticism will eventually be forthcoming in any event and it should be much more useful if it were made available early in the investigation. In so far as in us lies, we should avoid wasting our own time and facilities and those of our colleagues.

As I have emphasized elsewhere, it ought to be of enormous value to botanical science if some organization (perhaps the National Research Council) might publish yearly a list of what seem to be important and promising and feasible problems for botanical investigation, with elaborated plans. My imagination pictures this list as rather long, including all sorts of projects, sent in by numerous thinkers who have the well-being of their science really at heart, and I should expect it to alter from year to year, as projects get undertaken and results are obtained. It would be a fine thing if each society of research worker were to take upon itself the responsibility of furnishing such a series of proposals. This should be accompanied by a

usable bibliography of each problem, and mention should be made of investigators who might be engaged in this sort of work.

If this dream might come true such an annual publication might do more toward giving us a rather clear picture of the aims and trend of our science than could be secured from any other simple form of organized cooperative effort.

(*b*) *The Procuring of Data.*—After a research problem has been selected and properly planned, the securing of the requisite observational or experimental data is a matter of comparatively little difficulty. This is the easiest part of investigation and many publications consist of but little more than tabulations or lists of the data secured, without serious attempt to exhibit either plan or interpretation. This phase of research requires special attention, less than do the other two and I need not dwell here upon it. I may suggest, however, that when practical difficulties arise during the progress of a piece of experimental or observational work, it would be well for the investigator to call upon some of his competent colleagues for advice, and it would also be well for the rapid advance of our science if the persons thus asked might respond in a wholehearted sort of way. Let it be remembered in this connection that botany is a world science and that its advance is not to be accelerated through the usual operation of institutional or individual rivalries and jealousies. Such motives may have value if rationally controlled, but they do not appear generally to result in the building up of an *esprit du corps* among scientists.

(*c*) *The Interpretation and Presentation of Results.*—It frequently follows that a good plan systematically carried out gives results that are largely interpreted by the plan itself. If a quarryman cuts an ashlar expressly for a certain position in a wall it is not necessary for him to explain to the builder just what is to be done with it when it is delivered. But the case is not nearly always so simple as this when complicated problems are under investigation. And most biological problems are still so complicated (largely because they are chosen to embrace too large a field in each case) that special effort is required to find out what may be the meanings of the data at hand.

It appears that comparatively few writers take the trouble to interpret their results in anything like a logically complete manner. Our interpretations are generally hurried and are apt to be biased. Out of a large number of logically possible conclusions we are apt to state but one and to pretend that the facts support this hypothesis more than the others. Indeed, we usually write our discussion from the standpoint of a single one out of several or many logically possible hypotheses. The general result is that our literature abounds in published data which are either uninterpreted or illogically or incompletely interpreted. One of the greatest wastes in biological research lies, to my mind, in the publication of so many uninterpreted observations. To the beginner in research it may seem that a grateful science should be willing to interpret these data if the writer will just present them, but this is found not to occur in practice. As a general rule, if an author does not interpret his own results they remain uninterpreted and are finally lost in the maze of the literature; most active investigators do not like to attempt the study of the logical possibilities suggested by results obtained by some one else, especially as the plan followed in obtaining such results is apt to have been different from what the second investigator might wish to employ. It were better if we performed far fewer experiments and devoted much more time and energy and care to logical planning and thorough interpretations of the results we secure.

Just as in the case of choosing and planning an investigation, so in the case of interpreting observational and experimental data, several brains are preferable to one, and cooperation is greatly to be desired. It seems highly desirable, indeed, that several competent minds might be asked to make suggestions regarding any research at several times, from its inception to the publication of the resulting contribution. If some of our critics might be asked to criticize our papers before they are published, a great many mistakes and misunderstandings might be avoided and a good deal of personal jealousy and righteous or unrighteous indignation—both of which waste energy and time and money—might be prevented. Some of the standing committees of the Ecological Society of America have arranged for this sort of pre-publication criticism and it promises to be a valuable feature in raising the standard of research publication.

Cultivation and Tapping of Castilloa Rubber in the Philippines*

By Vicente C. Aldaba

INTRODUCTION

This work was undertaken on the plantations of the Lais Trading and Development Company in Davao, Mindanao. Conditions incidental to any plantation, and the location of this one in particular, limited the study to questions of immediate practical importance which do not require any complicated and costly apparatus. As no library was accessible it was not possible to make a thorough study of the references which should guide the course of the study and which might also modify some of the conclusions arrived at. And lastly, the lack, absolutely, of technical advice during the study, lessens the value which this paper might otherwise have.

On the other hand, the ample supply of material for extensive observations and the opportunity for testing by putting into actual and extensive practice any conclusion arrived at, will, it is believed, make the results highly reliable and practical, qualities which would hardly be possible of results obtained under other conditions.

The writer is in direct charge of 80,000 trees and is very familiar with the native plantings, numbering 70,000 trees, in the immediate neighborhood. He is also more or less familiar with the plantations in nearby places, so that observations cover an aggregate of 270,000 trees varying in ages from one to eleven years and planted under all sorts of conditions. Most of the plantings are about five years old. It will thus be seen that the plantings were increased only after their commercial aspect under local conditions was a demonstrated success sufficient to justify the further extension of the plantations.

The original seeds were secured from Ceylon and planted in December, 1906. These seeds became the source of the seeds of the plantings made afterward on the plantations of the Lais Trading and Development Company and also of most of the other plantings around the gulf of Davao. The steady increase in the plantings made is shown by the orders for seeds from this plantation. Seeds are sold at ₱4.00 a thousand packed and delivered on board.

Tapping has been going on ever since the oldest planting was three years old. There being no previous experience to serve as a guide, both the methods of culture and of tapping have been a continuous experimentation and what has already been accomplished is shown by the number of standing trees and by the optimism of the men in charge.

It is believed that the widespread unpopularity of Castilloa rubber in the Philippine Islands is mainly due to the fact that so few are familiar with it. This is not strange, considering that it has not received any systematic study in the Philippines. How much it is ignored by the public may be gauged by an article of twenty pages in the *Philippine Agricultural Review*, third quarter, 1917, entitled "The Rubber Culture in the Philippines", which deals entirely with Para rubber, devoting a footnote of eight lines to the exports of Castilloa rubber from the gulf of Davao. This was unjust, considering that there were at least 270,000 Castilloa rubber trees against 90,000 Para rubber trees in the Philippines at the time the article was published.

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*Thesis presented in partial fulfilment of the requirements for the degree of Master of Science, University of the Philippines; Experiment Station Contribution No. 8.

HISTORY AND BOTANY

The first record of the discovery of rubber by white men was dated 1525 in Mexico. The Central American rubber tree, also known as the Mexican rubber tree, was first described in 1794 and was named *Castilla elastica*, in honor of a Spanish botanist, Castillo. It belongs to the family *Urticaceae*. The generic name is more commonly spelled *Castilloa*.*

Subsequent studies have shown that *Castilloa elastica* is a very heterogeneous species and consists of numerous forms more or less distinct. It seems that different places with different soils and climatic conditions have their own characteristic forms. Indeed there are such named species as *C. panamonsis*, *C. costa-ricana*, *C. guatomalensis*, etc., each named after the place where it is found wild. The climate of these places varies from very humid with almost continuous rain throughout the year to dry with six rainless or almost rainless months.

As to recognized species, botanists disagree. *C. markhamiana*, *C. lactiflua*, and *C. tunu* are generally recognized as being different in their adaptability and yield in quantity and quality of rubber. This is a fact of fundamental importance, which should be considered in experimenting with the plant in new places.

The first attempt to cultivate the Castilloa rubber tree was made in 1872 in Mexico. In 1906 there were "at least 82,620 acres" planted to Castilloa in Mexico alone. It is interesting to note that Castilloa is planted on a large scale in regions where labor is worth several times as much as where Hevea has been commercially successful.

Castilloa was introduced in the East (in Ceylon) in 1876 from cuttings obtained from the isthmus of Darien. In spite of its excellent growth, it did not gain permanent popularity in that country.

Shortly after American occupation in the Philippines, interest was aroused in the cultivation of rubber in the Islands and Castilloa was tried among other species. On the island of Basilan it was discarded in favor of Hevea. In the regions around the gulf of Davao approximately 300,000 trees have already been planted and quite a quantity of rubber from this source has already been exported.

BOTANICAL DESCRIPTION

A lengthy non-technical description of Castilloa is given by O. F. Cook in his monograph, "The Culture of the Central American Rubber Tree", published in 1903, accompanied by natural-size illustrations. The monograph by Hooker "On the Castilloa elastica of Cervantes and some allied rubber-yielding plants" is incorporated in the same paper. The botanical characters which are of importance in connection with its cultivation and tapping will be treated in this paper under the respective topics.

GEOGRAPHICAL DISTRIBUTION

"Castilla (1) grows wild from 21° north latitude in Mexico southward through Guatemala, Honduras, San Salvador, Costa Rica, Nicaragua, Panama, and also in northwestern South America. The area in Mexico is a belt ranging from ten to one hundred miles in width and extending from Tuxpan, in Mexico, to the western boundary of Campecho, a distance of about 500 miles. The extent of the rubber belt is also rather small in Central America where it can be said to follow the Cordilleras on both sides, while in South America, it grows on the western slope of the Andes of Ecuador and Peru". It will be seen that the

*The change first appeared in an English translation of Cervantes' account of the rubber tree, published anonymously in 1805. The change is against the recognized rules of botanical nomenclature. This name is adopted here for the reason that it is the name by which the tree is known by all planters.

Philippines lie entirely within the latitudinal range of the natural distribution of Castilloa. The exceedingly varied climate and soil of the Philippines, together with the many forms of Castilloa, differing in their requirements, make it very highly probable that there are some places where it can be successfully cultivated. That the range where it can be cultivated successfully is more extensive than the regions around the gulf of Davao, is proved by the favorable report on Castilloa in Ambos Camarines published in the *Philippine Agricultural Review* for December, 1910. When it is remembered that many economic plants of the Philippines were brought from Mexico or neighboring countries by the Spaniards, it seems strange that this rubber plant was not introduced earlier in this country. The probable explanation is that its seeds are very perishable.

METHODS OF CULTURE

There was a time when planting under shade was advocated and practiced as imitating the ways of Nature, since Castilloa is originally a forest tree and always found growing under larger trees. This idea is now known to be erroneous.

Planting under partial shade consists essentially in leaving a few standing trees here and there during the clearing of the forest for planting. These trees are to furnish shade to the young Castilloa during part of the day. If the trees left are of the kind that yield valuable products as lumbang* nuts or fruits, the question is not so much the advantage derived from their shade as their products, and therefore the distribution of the trees and the kind of shade they furnish are not of first consideration. Leguminous trees and those furnishing even light shade, provided their distribution satisfied the purpose of the planter, should be left.

Aleurites moluccána (L). Wild.

Planting in the open should consist in clearing the whole area to be planted and allowing exposure to the full heat of the sun and unbroken force of the wind. This method of planting, in its full sense, does not seem to be much practised by planters of Castilloa anywhere and does not appear to be advisable. A modification of this, as explained below, would be best under most conditions.

FACTORS DETERMINING THE METHOD OF CULTURE

The methods of culture to be adopted for any one crop depends on several main factors. In tobacco planting when leaves for wrapper are desired, the plants are set under shade, natural or artificial. In this way the supply of light for the photosynthetic and transpiration activities of the plants is reduced, and the latter adapt themselves to this condition by producing thin and broad leaves in order to catch as much light and have as large a transpiring surface as possible. The thinness admits of the rapid and uniform heating of the leaf and facilitates the escape of the evaporated moisture. But when tobacco is raised for filler, the plants are set in the open, thus letting them produce heavy thick leaves.

In the case of the coconut it has been conclusively demonstrated that the more the tree is exposed to the sun and wind the better it is, provided its roots are supplied with enough water for absorption to keep up with ensuing rapid transpiration. When the distance between the trees is so reduced that there is insufficient space for spread of roots and crown and the factors responsible for transpiration are greatly interfered with, thereby limiting the performance of this function to such an extent that it no longer meets the actual need of the plants, then they are in such a condition that the application of fertilizer will be un-

profitable, if not absolutely useless, and nothing will bring about their prolificacy, except cutting down some trees and giving the remaining ones more space.

In the case of Castilloa the product expected is neither the leaf nor the fruit, but rubber. Rubber is prepared from the latex which is obtained from the bark. Conditions which will promote the formation of the latex and the increase in area of the bark will therefore be the determining factors in deciding the method of culture to be pursued.

It is now maintained on good ground that the main function of the latex is to protect the plant against too rapid transpiration. O. F. Cook (2) submits evidence supporting this theory, based on observations on climatic influences on the composition and yield of latex and on the behavior of the desert plants. Later, Dr. Pehr Olssen-Seffer (1) presented experimental proofs using Castilloa for the subject of his experiments. He concluded: "When Castilla is grown under certain conditions, the quantity of latex produced in the trees is reduced to a minimum, while under conditions favorable to or assisting excessive transpiration Castilla will produce latex *as a means of protection*". Hence, in order to make a rubber plant manufacture more latex for its protection, transpiration must be stimulated. Rubber, as is shown by its empirical formula, C_{10} H_{16}, is made up of carbon and hydrogen. Carbon is obtained only through photosynthetic processes. Therefore, photosynthesis is also to be promoted at the same time that transpiration is stimulated in order to furnish material for the manufacture of latex. Increase in the area of bark will directly result from increased growth.

Therefore, whether the products expected are leaves, fruits, or rubber, the fundamental principles that govern the method of culture are essentially the same. It follows that planting in the open is the method for Castilloa. But there are considerations which will modify this method. These are discussed below.

LOCAL METHOD OF CULTURE

LOCATION, SOIL, AND CLIMATE

The plantation in question lies in a valley surrounded by low mountains on the north, west, and south and opens to the gulf of Davao on the east. The land is fairly level, sloping very gradually toward the gulf. There are plantings also on the hillsides. A river flows through the northern part and a creek through the southern. Pump-wells made a short distance from the sea-coast draw water at a depth of from two to three meters.

The soil is a deep alluvial deposit. The surface soil varies from very fine sandy loam on the higher part to clayey loam of loose texture and light red color increasing in thickness toward the sea-coast. On the north side of the river at about two meters below the surface the soil is clayey. The bottom part of the deposit is sandy and more or less gravelly in distinct layers, with the natural tendency to become coarser toward the bottom of each layer. The soil on hills and hillsides is a heavy residual clay of black color. It will be noted that the topography and nature of the deposit of the soil together assure a perfect drainage. Running underground water is manifested by the many small streams having their sources at places where the removal of the upper stratum has exposed the sandy layer below.

The climate is humid with a fairly evenly distributed rainfall. Most of the rains fall at night. As a rule the day is clear and the night cloudy. Rain of two days' duration is very rare. Typhoons are unknown, the place being in that part of the island of Mindanao which is effectively sheltered. Table I is from

the "Annual Amount and Distribution of Rainfall in the Philippines" from the *Philippine Agricultural Review*, and represents that of the town of Davao, about sixty miles north of this locality. It is fairly representative of the local precipitation.

TABLE I.—*Monthly rainfall.*

Months	Amount	Months	Amount
	mm		mm
January	110.2	July	208.9
February	141.6	August	207.4
March	164.2	September	203.6
April	190.3	October	242.3
May	252.8	November	176.4
June	234.2	December	208.8
TOTAL	2340.7		

It may be remarked that in this locality August and September have less rain than the months following and will compare with the first four months of the year. But the total rainfall can be represented by the total of the table.

CLEARING

The land is covered with second-growth forest, *Kleinhofia hospita L.* being the dominating species. In clearing, the undergrowth is first cut down. The larger trees are felled next and trimmed, the branches cut to pieces so as to produce a bed of trash as flat and close to the ground as possible. The main object in the whole operation is to so arrange the cut growths that they will burn well some five or six weeks later. The larger unburned trees and branches and stumps remain in the field. Most of these decay in less than three years.

Distance.—Distance in permanent tropical plantings is a point on which there are most varied opinions. It is one of the most important points in plantation operation and any mistake may mean large financial loss. Such mistakes are most evident in the early plantings of coconut and Para rubber trees and the cutting down of valuable trees is the only way of correction. No one distance is likely to be adopted by all planters for any one crop, since so much depends upon the local conditions. As a general rule, the more favorable the local conditions for the thrifty development of a plant, the greater, within certain limits, is the distance allowed.

Some planters are apt to consider the length of the roots as the main criterion for determining the distance between plants. There is no doubt that entangling of roots has unfavorable effects upon their growth. But if this is to be avoided in Castilloa the distance between the trees must be at least 30 meters. A closet pit 0.75 meter long and 15 meters from an eleven-year old tree exposed three roots about a centimeter in diameter and numerous small roots all confined to the upper 30-centimeter section of the soil.

Distances on Davao Gulf vary from 3.7 meters (12 ft.) to 5.5 meters (18 ft.). There is a tendency among the residents to plant more closely, and 2.13 meters (7 ft.) may be found. In the case of Castilloa, however, this short distance can not be too strongly condemned. The 5.5 meters distance is found among the latest plantings of the Company's plantations.

Lining and staking.—Lines are laid off enclosing squares of which the sides are equal to the intended distance between the trees. Stakes which in this locality are very economically made from the straight clean branches of *Kleinhofia* are then driven at each corner of the square.

The practice is as follows:—Two lines of stakes meeting at one corner of the field and perpendicular to each other are first laid down. This is done by first laying on one side of the field a line of stakes the distance apart desired. Then with the aid of a carpenter's square or by any other convenient method the other

line of stakes is laid off perpendicular to the first. For a line a string is used conspicuously marked at points equidistant, the distance between the points being the same as that desired between the trees in the field. For string, split rattan has been found very satisfactory, since it is not subject to stretching when moist or to contraction when dry.

Holing and planting.—While holing, in the planting of crops, is usually an item of considerable importance, in Castilloa planting on Davao Gulf it is easily and cheaply done. This is because the soil is loose, consequently holing does not call for expensive digging tools and heavy labor. Holes 20 to 25 centimeters deep and big enough to allow free play of the hand to bring the soil up to the surface are made with bolo or pointed stick. In some cases holes are made with a pointed stick forced into the ground to the required depth. That allowance of one plant for probable failure may be provided for, two holes near each other are made. In each is placed a seedling, then the hole is filled up with soil. Shoots should be produced in from three to four weeks. When the plants are well established, the poorer one is cut down.

The usual recommendation of digging the holes a few weeks before planting with the object of allowing the newly exposed soil to be oxidized is not followed. Because of the looseness of the soil and because of its sandy nature which gives it the tendency to return to the former condition after the first rain, the digging of bigger and deeper holes with the object of creating an ideal condition for root development is not likely to result in enough improvement to justify the extra expenditure of labor for larger holes.

Seedlings beginning to or already having several small branches varying in height from three-fourths to one and one-fourth meters and about one to one and one-half centimeters in diameter at the base are pulled up in the older patches where they have been growing from fallen seeds. At this stage the seedling has one strong tap root and a few slender and weak lateral roots. Most of the lateral roots are left in the ground when the plant is pulled up. Thus, seedlings already of good size and very well suited to the local conditions and method of planting and easily pulled up are secured most economically. They are cut off at the top at about the first branch, thus taking away almost all the green part, and also near the roots leaving a tap root of from 10 to 15 centimeters long. These pole-like seedlings are tied in bundles and taken to the field where they are to be planted.

It may be mentioned in this connection that, if no other crop is to be grown on the plantation, no fencing is necessary, as wild hogs do not touch Castilloa. When the destructiveness of wild hogs in plantations of abaca, coconut, or Para rubber seedlings is remembered, it will be admitted that this advantage of Castilloa is of no mean importance.

Replanting.—Replanting of vacant hills should be attended to as early as possible. Because of the rapid growth of Castilloa, replanting should be done within a year. Later than this the newly planted seedlings will be so shaded by the older ones that their growth will be much retarded. In connection with this it is always well to remember that vacant hills do not only mean that much less of crop but more grass, which is the more important reason for not neglecting replanting.

Cleaning.—As a general rule cleaning is done four times during the first year, two times during the second, and once in the third year. After the third year, practically no more attention is paid to cleaning. In fact when the plant is given a good start and is favorably

located it needs little or no attention after the second year. When cogon and "siling-siling" (*Panicum sp.*), are the dominating weeds, about 0.75 meter is cleared around each plant. If the weeds consist of bushes and outgrowth from the remaining stumps these are cut down.

When bushes and shrubs are kept cut down so that they do not shade or crowd the crown of the Castilloa, they have no appreciable effect on the general thriftiness of the trees. *Kleinhofia* and many other bushes are able to compete with and kill the cogon and other grass. Patches have been seen where *Kleinhofia* has covered the ground to the exclusion of any grass growths. The encouragement of the growth of *Kleinhofia* and other bushes or shrubs is therefore advisable. When kept down low, they yield to the shading of Castilloa when the latter grows large and shades the ground.

This method of culture, with Castilloa on Davao Gulf, is more advisable than clean weeding and much cheaper, of course. It is true that the ground completely covered with vegetation loses more moisture than if kept clean and cultivated and possibly even more than uncultivated clean ground. It is also true that the chance for the absorption of plant food is much reduced. As to the plant food it has been pointed out already that bushes and shrubs, as long as they do not shade the Castilloa, have no appreciable effect on its thriftiness. As to the question of moisture there is no need of economy where there is plenty of rainfall and it is evenly distributed, and should a necessity arise for control, it would be only a matter of cutting down the bushes, and a perfect mulch would be formed.

In this method of culture there is one point of importance that is apt to be overlooked. In permanent plantings, where clean culture is practiced, applications of artificial or natural fertilizer must be made sooner or later; this means an expense which very often is heavy. Fertilization becomes necessary, since there is no way of preventing the soil fertility being carried away by water pouring over the surface, or being lost through leaching. Also, organic matter is continuously removed in the form of dried leaves. Cutting out grass and bushes is not only injurious in reducing the fertility of the land but it also leaves the soil in poor physical condition which can be improved only by expensive labor. On the other hand, when vegetation covers the ground the plant foods which might otherwise be lost through leaching are continually taken up by the vegetative covering. When the vegetation dies, this plant food is accumulated in the soil in the form of organic matter. Since it is a process of continual dying of some plants and the growing of new ones in their places the return of plant food to the soil is constant. The decaying organic matter causes more plant food in the soil to be dissolved. The washing of the surface soil, which is very rich, by streams of running water is almost entirely prevented. The conditions for the existence of organisms beneficial to the soil are improved. All these result in continuous accumulation of plant fertility.

It is well known that newly cleared lands are very fertile. The fertility of these lands has been accumulating for years, as forest soil gradually becomes richer. Planters of experience take the size of the trees in a place as an index of its fertility, the place where the trees are largest being the most fertile.

Of course this kind of culture where grass and other vegetation are allowed to grow can not be practiced with all kinds of crops, since few can live thriftily under these conditions. In many cases, for the sake of quicker and larger returns, clean culture and application of ferti-

lizers are economically practiced. That Castilloa reacts very favorably to this treatment is proved by the larger size of the trees that grow by houses. However, that such treatment will result in greater financial returns than the present inexpensive culture remains to be proved. At present, the limited amount of labor —and this is the important reason— makes the method of clean culture out of the question.

PESTS AND DISEASES

There are not many pests and diseases of Castilloa on Davao Gulf and those that are present have not proved to be any considerable menace. The natural situation of the plantations and the present conditions of communication make it easy to guard against the introduction of foreign pests and diseases.

The white ant.—A species of this insect is the most conspicuous of the enemies that attack Castilloa in this plantation and apparently does the most damage. It may be seen eating through the bark and wood at the base of the tree, stripping the tree of its bark even up to as high as a meter or more, until the tree is finally killed. It is interesting to note the comparative absence of its attack in young patches, especially where trees are under two years of age. During the first two years logs are plentiful and these supply abundant material for this insect's activity; it seems that only when decomposition destroys the logs is the termite's attention forced to the Castilloa trees.

Dr. F. W. Foxworthy of the Forestry Department of the Federated Malay States, in a personal letter to the writer, expresses the belief "that where the attack of anay (white ant) has been serious in the Para Rubber plantations on the Malay Peninsula, the anay have usually entered the stump of a tree that was chopped down and have worked down through the roots and then through the ground to the roots of other trees". So far, investigation here shows that the white ant is not able to injure a sound Castilloa tree. Cases have been met where the channels of the white ant pass immediately under the roots without touching them. The white ants built their channels on quite a number of trees and the ground below the surface was more or less netted with their trenches, yet apparently very few trees died from their attacks. This shows that this insect does not do much, if any, harm to sound trees. Observations on attacked trees that have been tapped show no impression on the uncut bark, but the dried part which is the result of tapping and which covers the new bark has been eaten away. Many trees that have apparently been killed by anay attack have been found to have been previously weakened by other causes. In many cases where the injury to bark has resulted in the exposure of the bark long enough to cause dying and drying, the white ant has started operations at this point. A big lateral root cut near the base of a tree in building a road was attacked by the white ants at the exposed wood.

Fungous and bacterial diseases.—Diseases from these two sources have not yet received much attention. It can hardly be doubted that close study would bring to light some that may be a possible menace in the future. But the fact that practically nothing has yet been done toward ascertaining the extent of their presence and of the injury that they may do is evidence of their practical harmlessness, if not absence so far, rather than of negligence.

SEED BEARING HABIT

Some trees begin to produce flowers at the age of two years.* Most of them

*Unless otherwise stated, age is counted from the time of transplanting.

however begin to reproduce a little later. At first the flowers are few and those that produce pistillate flowers produce fertile seeds. With each pistillate flower may appear one or two staminate flowers of different form than the true staminate flowers and smaller and apparently sterile. In older patches trees bearing each kind of flower are about equal.

The fruits turn bright red and fall to the ground as they ripen. The fruiting season lasts throughout the year, there being some trees bearing in every month of the year. The month of July probably gives the heaviest crop. Thus seeds are obtainable at any time in a smaller or larger quantity. The number of seeds in a fruit varies widely, from 18 to 21 being the most common. The quantity of seeds produced by a tree four or five years of age is very large since a fruit is produced at the base of each leaf and twenty or more fruits may be borne on each temporary branch.* A tree four or five years of age will easily produce three to four thousand seeds. The fruits are eaten by birds for their pulp and in this way the seeds are distributed. The common crow, (*Corone Philippina Bonaparte*) and calao (*Hydrocorax hydrocorax L.*) are the most frequent visitors. In patches less subject to the disturbance of people wild chickens. have been seen in numbers eating fruits Bats are also known to eat the fruit.

The seeds are perishable and soon lose their vitality unless they are given the chance to germinate. They are easily injured by desiccation and when cleaned of the pulp and kept moist they are attacked by fungi which blacken the interior of the seed and kill the germ. However, when the seeds fall on ground that is shaded, they germinate in from two to three weeks, the fleshy envelope keeping them in a moist condition. When the seeds are to be grown in the nursery, they should be shaded and kept moist until they germinate, when the shade should be removed to give as much light as possible to the seedlings. When immediately placed on the ground, as is the case with fallen seeds, the percentage of germination is very high, as may be seen in the germinating seeds under bearing trees. In the oldest patch (11 years old) Castilloa seedlings cover the ground to the exclusion of all other growths. The number of seedlings was 603 in a square meter of ground selected as representative of the average.

*Castilloa trees produce two kinds of branches. One kind falls from the tree as it gets old and the mark left quickly heals. The other kind, which is produced at the side of the temporary branch or of its mark, is permanent and grows large as the trees become old. This branch of course produces temporary branches for bearing the leaves. A temporary branch, in some cases, although rarely, when injured in some way, may produce a permanent branch which in turn produces temporary branches. In this case, so far as the writer knows, the temporary branch bearing the permanent branch becomes permanent.

LIGHT REQUIREMENT

Castilloa is found wild in second growth forests (2). Observations on Davao Gulf of trees grown from seeds distributed by animals show that it will grow thriftily in a more or less open second growth forest. It will continue to increase in size and successfully outstrip its rivals of low "parang" bushes if it receives a reasonable amount of light at the start. The rather rapid growth of Castilloa gives it a natural advantage in competition with the trees of its own rank. Its trunk will continue to elongate without very appreciably increasing in circumference and without producing any branches until it gets above its competitors and is able to place its foliage in a good position for receiving light. Then the branches develop to support a a more ample foliage and the diameter of the trunk increases also. This is especially true of trees planted in abaca fields. Seeds which happen to be dropped under very dense shade germinate, but produce few leaves and finally die.

Trees which are forced to compete with other plants are much slower in growth than those that are able to obtain all the space they need. The trunk is small, the temporary branches small and spindling, and the leaves few. In places where the forest has been cleared and the Castilloa left to stand alone, they invariably develop into much more robust trees than when in an uncleared forest. The most conspicuous differences are the rapid increase of girth, the increase in size and number of branches, and the increase in number and hardiness of leaves. The increase in height of the trunk is, on the other hand, greatly retarded. Comparison of the appearance of two trees, one in forest and one in clearing, will show that the one under forest conditions needs more light for full development than it is able to procure in its forest habitat. The same is found to be true in the observations made in its native country. In "Southern Mexico,....trees standing in the open sun and with little other vegetation near them are not only able to survive six months of dry weather, but actually remain more leafy at the end of the dry season".

THE LEAF

The leaves of Castilloa are arranged side by side in two rows on the temporary branches. The older branches are longer than the upper younger branches. The leaves fall as they get old or as their function ceases by being shaded by the leaves of the upper branches, so the bases of the lower branches are almost leafless. These temporary branches fall off as they get old. Generally when young, that is, under three years of age, the plant develops no true branches. As a result, the crown is in the shape of a cone and the arrangement of its foliage for catching light is perfect. Indeed, under a normal Castilloa tree of this age there is almost complete shade at noon time. In a Castilloa plantation six or seven years old where the distance between trees is 4.6 m. (15 feet) dried up branches under the root of the Castilloa foliage are common. The branches died through being entirely shaded.

Leaf area.—One tree measuring 31.3 centimeters in girth at 90 centimeters above the ground and 384 centimeters in height has 570 leaves and 35 branches. The area of a leaf taken from the middle of a branch of middle age is approximately 560 square centimeters. The total area of leaf surface on the plant is therefore approximately 32.09 square meters. The length of one of the lowest branches is 2.15 meters and this can be taken as the radius of the circular space of light received by the tree at noon. The area therefore of the leaves that are receiving direct sunlight at noon is 14.52 square meters. In other words, even with the advantageous arrangement of leaves that Castilloa has, only about 45 per cent efficiency can be obtained.

GROWTH

As is mentioned above, trees forced to compete with other trees do not grow as fast as trees in the open. They continue to increase in height without proportional increase in diameter and do not produce permanent branches. On the other hand, trees growing singly in the open increase in diameter very rapidly and produce permanent branches at about the height of three meters. After the formation of permanent branches the increase in height is retarded, the trees maintaining heavy foliage. Neither of these two extremes, however, is met under plantation conditions.

Table II gives the measurements of trees from eight blocks which were selected to represent the different conditions that exist in a plantation. Girth was

measured at 90 centimeters above the ground and the height of only one tree from each block which represented the average of all in that block was taken. In Block VII the height of two trees, one of the lowest and the other of the highest, were measured. It may be mentioned here that trees under plantation conditions are about equal in height. One or more rows about the middle of each block were selected and the circumferences of all trees in those rows were measured until the number reached fifty. Those that had branches at or below 90 centimeters above the ground, those that were planted later to fill vacancies, and those that were abnormal in growth were excluded. In cases where two trees were standing in one hill only the larger was measured. Block IV is a section of a large block which is used for "variation of yield" experiment. (See Table VII A, B, C, and D.) All trees in this block were measured irrespective of all considerations set forth above. It however represents very fairly the average for the whole block.

DESCRIPTION OF BLOCKS

Block I is on the north side of the river where the soil is clayey loam even at the depth of two meters. The trees completely shade the ground and practically no attention is given to it. The only weeds are a thin stand of a kind of grass locally known as "siling-siling" (*Panicum*), and that is rapidly being driven out. Next to Block I is a block of younger trees where the ground is covered with a thick growth of cogon (*Imperata cylindrica L.*). The trees are already beginning to produce flowers and, doubtless, as soon as abundant seeds are produced, Castilloa seedlings will gradually cover the ground to the exclusion of any other growth.

TABLE II.—*Growth of castilloa in plantation*

Age	Block I		Block II		Block III		Block IV				Block V		Block VI		Block VII		Block VIII	
	2 years and 1 month		3 years and 1 month		4 years and 1 month		6 years and 2 months				7 years and 2 months		1 year and 2 months		1 year and 11 months		1 year and 11 months	
Ave. Ht.	12 feet 7.5 m.		....		12 ft. 13 m.		12 ft. 14.0 m.				15 ft. 12.0 m.		15 ft. 17.0 m.		28-8-9 m.		7 ft. 7.0 m.	
1	47.6	38.0	50.5	46.8	52.0	52.2	37.0	64.1	79.6	98.2	90.3	86.8	111.0	121.6	17.4	22.9	44.0	36.9
2	36.7	41.6	32.8	42.3	51.4	63.1	38.3	65.5	79.8	98.2	68.2	73.6	130.1	135.8	29.5	22.5	32.7	39.2
3	30.3	42.3	58.9	48.8	64.4	62.2	40.1	64.6	80.1	99.2	56.3	62.5	113.3	114.4	29.4	19.6	48.8	38.6
4	35.8	42.9	48.5	49.9	62.5	69.4	46.6	64.7	80.8	100.0	88.7	71.0	136.8	112.6	14.2	26.4	33.9	37.4
5	38.2	36.7	51.4	50.3	57.2	64.3	50.6	64.7	83.9	105.7	68.9	59.0	96.5	88.1	14.0	8.7	38.1	38.5
6	33.7	37.5	49.6	51.0	46.9	64.2	50.8	65.0	84.8	107.6	62.3	66.1	119.8	118.9	9.3	18.5	34.6	32.0
7	41.9	37.1	46.6	59.2	48.1	60.8	51.2	65.0	85.2	110.5	44.5	69.2	131.3	93.2	15.8	12.8	42.2	43.6
8	53.4	44.0	44.3	69.5	59.5	64.9	51.3	65.9	85.3	113.2	66.0	49.5	112.6	77.5	10.2	13.4	38.7	35.0
9	47.9	48.3	46.7	52.0	37.8	67.4	53.3	66.9	85.7	119.6	66.2	72.3	127.2	138.2	14.0	9.1	47.8	41.2
10	41.8	45.1	44.9	47.3	57.6	69.2	53.9	67.9	85.8	129.4	59.4	98.2	128.1	82.5	9.9	12.9	43.1	34.3
11	36.7	47.7	41.3	45.7	43.7	67.8	54.6	67.9	85.3		73.8	60.9	112.0	105.5	12.2	12.2	34.6	40.9
12	36.9	34.1	52.3	52.3	55.8	65.6	54.7	68.4	86.4		76.0	66.5	97.9	92.5	15.6	13.3	36.4	34.0
13	23.7	32.9	53.0	36.0	49.0	55.2	56.6	68.6	86.6		71.5	56.3	126.5	133.7	17.4	33.7	44.8	29.0
14	51.2	41.3	55.7	51.5	57.9	58.8	57.6	68.7	88.5		90.4	68.6	104.1	95.2	29.0	25.5	32.2	37.6
15	45.2	44.6	49.2	41.9	55.6	66.3	88.0	69.6	88.5		60.0	17.0	100.3	100.9	19.6	17.7	34.2	41.0
16	49.1	40.8	45.1	47.9	40.8	76.2	59.1	71.8	88.9		59.3	109.1	124.0	107.5	22.9		29.7	42.5
17	46.6	31.1	57.8	53.7	54.5	57.4	59.6	71.9	89.4		63.2	108.4	120.0	129.6	14.3		29.1	38.0
18	48.8	39.2	58.2	40.4	42.7	67.3	60.2	71.9	90.3		64.8	82.9	86.4	131.9	16.2		26.0	38.5
19	42.8	39.4	49.4	36.5	53.8	64.0	60.2	72.3	90.8		62.5	67.4	92.0	92.7	29.5		28.2	26.9
20	48.6	34.1	49.7	41.4	54.9	67.2	60.9	72.3	91.2		54.5	68.6	122.2	136.9	14.5		28.3	37.2
21	42.2	39.4	49.8	42.6	43.2	68.9	61.7	73.0	93.2		65.4	50.6	102.3	116.8	9.4		36.4	30.8
22	53.6	33.2	50.5	48.9	45.4	62.6	61.9	73.3	93.6		59.7	69.0	85.3	137.0	19.6		32.9	26.7
23	51.5	39.3	59.8	44.8	57.2	49.4	62.8	78.0	96.3		74.8	62.3	119.4	136.8	12.5		60.2	34.0
24	47.8	42.0	53.7	55.9	53.1	78.3	63.1	78.3	96.9		66.3	64.5	129.4	107.1	12.6		42.5	44.3
25	49.8	46.6	49.3	51.3	68.0	54.9	63.1	79.2	97.7		66.3	64.5	129.4	107.1	12.6		36.3	43.0
Average		41.7		49.2		58.2			76.4		69.3			114.1	17.2			37.0

Block II is also on the north side of the river and was given one cleaning in the third year. The weeds are a mixture of many kinds but cogon and siling-siling in a rather thin stand dominate. To all appearances the Castilloa trees are succeeding in rapidly choking out this undesirable vegetation. When seedlings begin to be produced in large quantities, it will help in exterminating the weeds.

Block III is on the south side of the river and the soil is a very fine sandy loam. There are two trees to the hill and all of them look healthy. The ground is completely shaded. No weeds exist on the shaded ground. This block has been tapped twice.

Block IV is on the north side of the river. The weeds are a mixture of cogon, siling-siling, and other bushes. This block has been tapped for several years. Cleaning is attended to by the tapper who cuts the undergrowth around each tree to give freedom in tapping. Castilloa seedlings are already the dominant growth in many places.

Block V is at the foot of a hill. The soil is a rather gravelly loam. The weeds are a very thick growth of siling-siling and cogon. This block has been tapped for several years. No cleaning is done except around each tree by the tapper. The trees are not in a very healthy condition and present the symptoms of improper nourishment. The bark appears grayish white at a distance, due to growth of lichens, and the temporary branches are small and fall prematurely so that only a few are present at a time on the tree. The marks left by the branches are raised above the surface instead of being sunken, as in a normally growing tree. The leaves are yellowish, small, and few in number. The terminal shoots are sometimes dried up.

Block VI has the oldest trees. The soil is very fine sandy loam. Castilloa seedlings are practically the only growth under the trees.

The trees in Block VII are interplanted among abaca and are very well cared for. The trees must have been of rapid growth when the abaca was still young but after about a year when the abaca began to shade the ground their growth was retarded. Those that were completely shaded stopped growing and finally died, as is shown by many vacancies. Those that were fortunate enough to receive some light from above are persisting and sending their crowns upward over the abaca.

Block VIII is an ordinary farmer's planting on a hillside. The soil is heavy residual black clay. It has been cleaned two times since it was planted. Many trees are branching below 90 centimeters above the ground. In many hills there are three trees. In measuring, hills with three trees were rejected. The Castilloa is taking possession of the ground. The weeds consist of low bushes and a thin growth of siling-siling.

From Table II, it can be seen that during the first two years occurs the most rapid growth of Castilloa and any care given to it at this time will for this reason certainly pay in the long run. When unhindered in its development at this age, it is already able to choke all weeds, further invasion of which need not be feared any longer.

In the third year the increase in girth is only 8.5 centimeters, as shown by the older blocks; this continues to be about the average annual increase. At the age of four years tapping can begin on trees with 60 centimeters girth at 90 centimeters above the ground.

Block V shows that thick growth of cogon and siling-siling sets back the development in girth two years. Nor are those trees as tall as in the other blocks.

Block VII shows very markedly the effect of reduced sunlight. The rapid growth of these trees that are planted among abaca but have already grown high enough to be able to obtain all the light they need proves that the association with abaca does not have much, if any, ill-effect upon Castilloa trees. And since the place is well cared for the slow growth can only be attributed to the reduced light. Actual observation showed that the size of the trees is in direct relation to the openness of the place where they grow.

Writers on Castilloa state that it needs an open porous soil. The growth of trees in Block VII proves that heavy clay soil is not objectionable. It is very probable that the objection to heavy clay is due to the imperfect drainage which usually accompanies such soil. But when heavy clay is in such a position as to insure efficient drainage the growth of Castilloa is as good on this soil as on that which is more porous. The average for Block VII is 37 centimeters for 23 months against the 41.7 centimeters for 25 months for Block I. Block VII has been cleaned only twice since planting and the distance is 2.13 meters (7 feet).

It may be mentioned in connection with growth that good drainage is essential to Castilloa. In a small patch where the water table is only about 20 centimeters below the surface, the plants do not increase at all in height. They increase a little in girth and maintain several branches with few thick, yellow leaves, showing that they are unable to draw water. In all the examinations made the tap roots are decayed. In cases where the formation of the crown has taken place before the formation of strong enough lateral roots to support it, the trees fall to the ground and maintain a few thread-like lateral roots.

VARIATION IN RUBBER YIELD

That the yield of rubber by individual trees varies and that improvement can be attained by selecting and propagating the best yielders is to be expected. Improvement by selection and propagation of the most desirable types has been effected in all kinds of crops, no matter whether the products are obtained from the reproductive organs, from the leaves, from the stems or from the roots. The doubling of the quinine content of cinchona bark by selection is probably the best example to show that even if the product is obtained from the bark, it is susceptible of improvement by selection. Fruit growers have found that some trees do not pay even for their cultivation and should be cut down; to a certain extent this has been found true with Castilloa trees. Of 25 trees observed in one tapping of four cuts 30 centimeters apart and one-half around the trees, only 100 grams were obtained, giving an average of four grams a tapping for each tree, while it is not uncommon for other trees of the same age and tapped in the same manner to yield more than 10 times as much in one tapping. The trees in the latter case are larger and therefore when tapped all over still more rubber, in comparison with the poor yielding trees, will be obtained. Table IV (A, B, C, D,) shows conclusively the great variation of yield of dry rubber from the same area of different trees.

VARIATION IN QUALITY OF RUBBER

Rubber varies in quality in two ways: (1) The rubber is weak and difficult to collect, and (2) it is hard and very resinous. That the first is due to individual variation is proved by the fact that rubber of varying degrees of weakness is found. As to the second, it is exceedingly hard, if not impossible, to distinguish the different degrees of resinousness by mere look or touch; but ex-

perience seems to show that even from seeds of a single tree such variation occurs. It may be mentioned in connection with this that the method of collecting rubber makes possible the exclusion of that of undesirable quality. If the latex is all collected together and then coagulated, the latex of weak and of resinous rubber will be mixed.

IMPROVEMENT BY SELECTION

Selection and isolation of good yielders and propagation from them is especially hard and requires time in the case of perennial plants, but there is no reason why it can not be accomplished. Naturally, it would be easier to select the best trees and propagate by cuttings from these. But this would be a slow process, since Castilloa produces only a few true branches and the temporary branches do not develop into robust trees. (2) Since results from the usual method of selection will require years of work, for purposes of immediate practical importance some other means must be found, if possible.

It has been repeatedly observed that trees of a certain form invariably give more rubber at each subsequent tapping than the others. In order to find out how far that relationship is true, a block of 85 trees was selected and tapped by making 13 horizontal cuts, one above the other, 20 centimeters long and eight centimeters apart so that the rubber from each tree was obtained from the same area. Each tree was noted as to the following characteristics:

Regularity of the cross section and outline of the trunk, mainly observed at the base.—Many trees have an irregular surface at the base. There is a disadvantage in this since the tapping knife can not cut the bark of the concave surface very well while that of the convex surface is cut rather too deep. In most cases this irregularity is due to the formation of large lateral roots which tend to form a kind of buttress. Such large lateral roots are the direct result of the rapid growth of the tree which needs them for the support of its heavy crown. The trunk of such a tree tends to become round a short distance above the ground as the tree gets older. However, the irregularity may be due to the poor growth of the tree in which case it extends higher up the trunk.

Regularity of the cross-section outline does not, however, mean poor growth necessarily, as might be deduced from the above. There are trees of very beautiful form bearing dense crowns on strong trunks and with large lateral roots also, but with little tendency to produce the buttress-like formation. There are also trees with regular girth but stunted in growth.

Tapering or non-tapering.—Of course all trees are more or less tapering. But there are Castilloa trees with very regularly tapering trunks and these can easily be recognized. There are also trunks which do not give the impression of tapering. The decrease in girth toward the top is not very regular and not very great. The regularly tapering type of trunk has been observed to give a good yield of rubber. The non-tapering type can be observed especially on rapid growing trees and it generally appears to be more robust than the tapering type.

To find the rate of decrease in circumference of the tapering trunks the following measurements were taken:

TABLE III.—*Taper of young castilloa trees.*

No.	Girth at base	Girth at 4m. above ground	Ratio
	cm.	cm.	
1	120.9	73.8	1.64
2	93.5	61.7	1.51
3	86.4	52.8	1.64
4	100.2	62.0	1.69
5	126.3	69.9	1.81
6	106.8	63.6	1.68
7	102.5	64.1	1.60
8	94.5	56.0	1.69
9	115.5	74.4	1.55
10	93.2	55.7	1.67
		Average ratio	1.64

Position.—Two positions are distinguished, erect and inclined. The latter includes all trees that are not erect. Inclined position may be due to the improper development of the roots or to the poor growth of the stem. In the latter case the more healthy neighbors cover it, thus forcing it to bend towards any open space for light. There is a practical disadvantage in this kind of tree, since tapping on the inclined surface is likely to let a large quantity of latex drip on the ground. In this experiment tapping was done on the side opposite the direction of inclination.

Branching.—Branching can be taken as an index of the thriftiness of the tree and those that have been able to branch earlier have an advantage over their neighbors. Therefore, branching is also observed up to as high as three meters. The height of branching is only estimated.

The leaves.—The leaves of a tree can also be taken as an index of its thriftiness. Size and color are the characteristics observed. Size is recorded as "average" when it is of the size of most trees of that age. It must be understood in connection with this that the leaves of Castilloa decrease in size as the tree gets older. Color is said to be green, yellowish, or dark green. Yellowishness would indicate greater thickness of leaves and more hairiness. Dark green would indicate the opposite.

The trees are separated into four types according to the appearance of the trunks: Regular and tapering, irregular and tapering, regular and not tapering, and irregular and not tapering.

Table IV gives the results.

TABLE IV.—*Yield of different types of Castilloa trees.*

(A) REGULAR AND TAPERING

No.	Girth 90 cm. above ground	Weight	Height of appearance of branches	Position	Description of leaves	
	cm.	*grams*	*meters*			
1	96.3	10.0	2	Erect	Average	Green
2	53.3	8.0	1	—Do—	—Do—	—Do—
3	64.1	10.5	.....	—Do—	—Do—	—Do—
4	60.9	13.7	2	—Do—	—Do—	—Do—
5	62.8	14.0	.....	—Do—	—Do—	—Do—
6	88.9	12.4	1	—Do—	—Do—	—Do—
7	93.2	10.6	2	—Do—	—Do—	—Do—
8	79.6	6.1	1.5	—Do—	—Do—	—Do—
9	105.7	11.6	1	—Do—	—Do—	—Do—
10	54.7	10.9	.....	—Do—	—Do—	—Do—
11	38.3	5.7	.....	—Do—	—Do—	—Do—
12	119.6	4.9	0.5	—Do—	—Do—	Yellowish
13	67.9	16.3	0.5	—Do—	—Do—	Green
14	59.6	11.7	.....	—Do—	—Do—	—Do—
15	93.0	17.3	0.5	—Do—	—Do—	—Do—
16	64.7	23.2	.....	—Do—	—Do—	—Do—
17	89.4	21.6	1.0	—Do—	—Do—	—Do—
18	69.4	11.9	.....	—Do—	—Do—	—Do—
19	67.9	12.2	0.25	—Do—	—Do—	—Do—
20	63.1	12.1	2.0	—Do—	—Do—	Yellow
21	80.8	19.2	.....	—Do—	—Do—	Green
22	99.2	7.5	2.0	—Do—	—Do—	—Do—
23	86.8	7.6	.....	—Do—	—Do—	—Do—
24	65.9	13.1	.....	—Do—	—Do—	—Do—
25	90.8	10.9	2.0	—Do—	Small	Yellowish
Sum	1915.6	303.0				
Ave.	76.6	12.1				

(B) IRREGULAR AND TAPERING

No.	Girth 90 cm. above ground	Weight	Height of appearance of branches	Position	Description of leaves	
	cm.	*grams*	*meters*			
1	73.3	9.5	2.0	Erect	Average	Green
2	60.2	9.2	.....	—Do—	—Do—	—Do—
3	63.1	6.7	1.5	—Do—	—Do—	—Do—
4	88.5	8.3	.....	—Do—	—Do—	—Do—
5	85.2	12.4	.....	—Do—	—Do—	—Do—
6	64.5	2.4	.....	—Do—	—Do—	—Do—
7	65.0	10.7	.....	—Do—	—Do—	—Do—
8	73.0	11.7	.....	—Do—	—Do—	—Do—
9	68.7	16.5	1.5	—Do—	—Do—	—Do—
10	72.3	7.8	2.0	—Do—	—Do—	—Do—
11	86.4	6.1	.....	Inclined	—Do—	—Do—
12	88.5	17.1	.....	Erect	—Do—	—Do—
12	88.5	17.1	.....	Erect	—Do—	—Do—
13	98.2	15.2	2.0	—Do—	—Do—	—Do—
14	79.2	12.0	.....	—Do—	Small	—Do—
Sum	1066.1	145.6				
Ave.	71.1	9.8				

(C) IRREGULAR AND NOT TAPERING

No.	Girth 90 cm. above ground	Weight	Height of appearance of branches	Position	Description of leaves	
	cm.	*grams*	*meters*			
1	96.9	3.4	0.75	Erect	Average	Green
2	64.6	6.1	1.75	—Do—	—Do—	—Do—
3	84.8	15.7	.....	Inclined	—Do—	—Do—
4	78.0	8.8	.....	Erect	—Do—	—Do—
5	46.6	7.6	.....	—Do—	—Do—	—Do—
6	110.5	13.1	.....	Inclined	—Do—	—Do—
7	113.2	10.1	1.75	Erect	—Do—	—Do—
8	66.9	11.4	1.50	—Do—	—Do—	—Do—
9	107.6	9.7	0.5	—Do—	—Do—	—Do—
10	51.3	7.0	.....	—Do—	—Do—	—Do—
11	97.7	9.3	2.0	—Do—	—Do—	—Do—
12	50.6	5.6	.....	Inclined	—Do—	—Do—
13	71.9	11.7	1.0	Erect	—Do—	—Do—
14	80.1	12.7	1.5	—Do—	—Do—	—Do—
15	53.9	6.2	.....	Inclined	—Do—	—Do—
16	68.6	7.6	1.5	Erect	Small	Yellowish
17	85.7	14.4	.....	—Do—	Average	Green
18	57.6	15.8	.....	—Do—	—Do—	—Do—
19	98.2	6.4	.....	—Do—	—Do—	—Do—
20	129.4	2.8	0.25	—Do—	—Do—	—Do—
21	100.0	13.1	0.50	—Do—	—Do—	—Do—
22	60.2	3.4	0.75	Inclined	—Do—	—Do—
23	83.9	17.7	.....	—Do—	—Do—	—Do—
24	90.3	11.4	1.5	Erect	—Do—	—Do—
25	91.2	6.4	.....	Inclined	—Do—	—Do—
26	82.3	9.1	1.5	Erect	—Do—	—Do—
27	69.6	12.8	.....	—Do—	—Do—	Dark green
28	59.1	14.2	.....	—Do—	—Do—	Green
Sum	2240.7	273.5				
Ave.	80.0	9.8				

(D) REGULAR AND NOT TAPERING

No.	Girth 90 cm. above ground	Weight	Height of appearance of branches	Position	Description of leaves	
	cm.	*grams*	*meters*			
1	37.0	7.0	.....	Inclined	Average	Green
2	65.0	10.7	.....	Erect	Small	Yellowish
3	71.8	10.2	.....	—Do—	Average	Green
4	78.3	5.7	.....	Inclined	—do—	—Do—
5	72.3	5.6	1.5	Erect	—do—	—Do—
6	61.9	8.2	2.0	—Do—	Large	Yellowish
7	58.0	2.0	.....	—Do—	Average	Green
8	79.8	7.8	.....	—Do—	—do—	—Do—
9	51.2	7.4	.....	—Do—	Small	—Do—
10	54.6	7.9	1.0	—Do—	Average	—Do—
11	40.1	6.4	.....	Inclined	Large	Yellowish
12	71.9	8.5	1.0	Erect	Average	Green
13	56.6	5.8	.....	—Do—	—do—	—Do—
14	64.7	4.3	1.5	Inclined	—do—	—Do—
15	50.8	8.3	.....	—Do—	—do—	Dark green
16	61.7	10.1	.....	Erect	—do—	Green
17	85.3	6.5	1.0	—Do—	—do—	—Do—
18	85.8	6.1	.....	—Do—	—do—	—Do—
Sum	1146.8	128.1				
Ave.	63.7	7.1				

The trees used in this experiment had been tapped from time to time and therefore the rather small yield for the area tapped in all cases should not be taken as the normal yielding capacity of the trees. It means only that the trees are not yet ready for retapping. This fact, however, would not have any effect on the results of the experiment.

It appears that the third type, Table IV (C), is the most rapid in growth as shown by the average girth of 80 centimeters. This is confirmed by extensive observations. The next most rapid is the first type, Table IV (A), with an average girth of 76.6 centimeters. In the yield per unit of area, however, the first type is the best. This fact confirms the Mexican experience. The second and third types, Table IV (B) and (C), are about equal.

SELECTION

If the supply of seeds is sufficient, ample provision for selection, based on the facts set forth above, will certainly pay in the long run. It has been demonstrated that a good yielder is to a large extent recognizable by its form. Therefore, the selection of seed from a certain form which is known to be characteristic of a good yielder will rapidly raise its number in a growing plantation.

Four seedlings should be planted 30 centimeters apart in the form of a square in every hill. This distance has been observed not to have any appreciable effect on the erect position of the trees up to three years old, when there are two to the hill. That number will provide both for probable failure and opportunity for selection. Should all four live, as can be expected of most of the hills if the weather is favorable, the two poorest ones should be cut down during the first year or in the early part of the second. As was often observed, the trees are likely to be weakened and become somewhat twisted in trunk as a result of overcrowding.

The two remaining healthy trees should be allowed to grow until three years of age. When two robust plants are present in hills at the distance of 4.6 meters, their foliage completely shades the ground at the age of two to three years and chokes any kind of weeds. In three years the form of each tree is

already recognizable and one of them may be cut down leaving the more desirable form. Should the price of rubber warrant it, these three-year-old trees can be tapped before being cut down. Even if no such tapping can be done, the help these trees will render in preventing the domination of weeds would be more than enough to pay for the extra labor required in planting them. And what is more important, selection is made possible. When two healthy growing trees are present to the hill until the age of three years, no opportunity for the thick growth of siling-siling and cogon would be given. In blocks where this has been done there are better stands of larger trees than where only one tree to the hill was left after the first year. This apparent paradox is readily explained by the fact that the grass enemies of the Castilloa trees are not yet well established when the combined crowns of the two trees to the hill arrived at the stage of being able to shade the ground and choke the weeds. On the other hand, when only one tree stands in a place, the grass enemies become well established before the crown of the trees arrive at the point when it would be able to shade the ground, and consequently the trees are arrested in growth and the grass dominates the situation. In native plantings where the trees are only 2.13 meters (7 feet) to 2.7 meters (9 feet) distant, invasion of the weeds had been completely checked by the time the trees had a good start. The effect is the same as having two trees to the hill 4.6 meters (15 feet) apart.

DISTANCE *vs.* YIELD

The distance between trees in Table IV is 4.17 meters (12 feet). It is supposed that the effect of limited space will be more sharply felt by the largest trees, since the proportion of light received to the size of tree would be least in the case of the largest tree, and this would be reflected by the yield of dry rubber per unit of area. To test this theory the figures of the tables above were arranged in groups of different sizes of girth of 35–45 centimeters, 45-55 centimeters, etc., and the average for each group taken. A curve was constructed for the averages obtained.*

The uniform rise of the curve from 35 to 80 centimeters girth is very striking. This can be accounted for mainly by two conditions: (1) The trees of smaller girth are crowded by their more vigorous neighbors, and (2) the lactiferous system of the trees below 60 centimeters girth is not yet fully developed, as will be shown later. Most of the trees below 50 centimeters girth will not probably reach tapping size since they are crowded by their neighbors. This emphasizes the importance of close attention to the early stages of growth of the plant. The depression of the curve between 90 and 105 may be partially explained by the fact that four of the seven trees represented belong to Table C. The two points between 115 and 135 are each represented by only one tree and it would not be safe to draw any conclusion from these.

Judging from the appearance of the whole block it is evident that the larger and more vigorous trees occupy sufficient space in proportion to size. Hence, any reduction in the plant activity due to the limitation of space will be felt quite equally by all. The determination of the relation between yield and spacing is being investigated by studying different blocks under similar conditions in which plantings are made at different distances.

*Omitted in publication.

TABLE V.—*Data of Table IV arranged according to groups of different sizes of girth.*

No.	35-45 Girth	Wt.	45-55 Girth	Wt.	55-65 Girth	Wt.	65-75 Girth	Wt.	75-85 Girth	Wt.	85-95 Girth	Wt.	95-105 Girth	Wt.	105-115 Girth	Wt.	Girth 115-125	Wt.	125-135 Girth	Wt. 2.8
1	37.0	7.0	46.6	7.6	56.6	5.8	65.0	10.7	78.0	8.8	85.2	12.4	96.3	10.4	105.7	11.6	119.6	4.9	129.4	
2	38.3	5.7	50.6	5.6	57.6	15.8	65.0	10.7	78.3	5.7	85.3	6.5	96.9	3.4	107.6	9.7				
3	40.1	6.4	50.8	8.3	68.0	2.6	65.9	13.1	79.2	12.0	85.7	14.4	97.7	9.3	110.5	13.1				
4			51.2	6.4	59.1	14.2	66.9	11.4	79.6	6.1	85.8	6.1	98.2	15.2	113.2	10.1				
5			51.3	7.0	59.6	11.7	67.9	12.2	79.8	7.8	85.3	9.1	98.2	6.4						
6			53.3	8.0	60.2	3.4	67.9	16.3	80.1	12.7	86.4	6.1	99.2	7.5						
7			53.9	6.2	60.2	9.3	68.4	11.9	80.8	19.2	86.6	7.6	100.0	13.1						
8			54.6	7.9	60.9	13.7	68.6	7.6	83.9	17.7	88.5	17.1								
9			54.7	10.9	61.7	10.1	68.7	16.5	84.8	15.7	88.5	8.3								
10					61.9	8.2	69.6	12.8			88.9	12.4								
11					62.8	14.0	71.8	10.2			89.4	21.6								
12					63.1	6.7	71.9	11.7			90.3	11.4								
13					63.1	12.1	71.9	8.5			90.8	10.9								
14					64.1	10.5	72.3	5.6			91.2	6.4								
15					64.5	2.4	72.3	7.8			93.2	10.6								
16					64.6	6.1	73.0	11.7			93.6	17.3								
17					64.7	23.2	73.3	9.5												
18					64.7	4.3														
Sum	115.4	19.1	467.0	67.9	107.4	174.1	180.4	188.2	724.5	106.7	1415.7	178.2	686.5	64.9	4377.0	44.5	119.6	4.9	129.4	2.8
Average	38.4	6.4	51.9	7.5	61.5	9.7	69.4	11.1	80.5	11.7	88.4	11.1	98.1	9.3	109.2	11.1	119.6	4.9	129.4	2.8

DISTANCE

In attempting to determine the distance likely to be best it must be borne in mind that it is not merely the total girth per hectare, as is the case with Hevea, but the total tappable area that is desired. And because of the method of tapping, the trees should be perfectly erect. This facilitates the use of a ladder on any side and does away with the unnecessary dripping of latex on the ground. An erect tree with a clean trunk up to six meters above the ground and bearing a compact conical crown should be the ideal.

It has been pointed out above that when a Castilloa tree is allowed all the space it requires, it tends to branch at the height of three meters or less. However, this is not the only time when branching is to be watched. It is apt to take place also after transplanting as a result of the cutting off of the end of the seedling. When the formation of branches at these stages is discouraged, the tree will develop a tall clean trunk.

In order to find out just what branching means on the desired tappable area, actual determination of the tappable area of 20 trees without branches as high as three meters, and another 20 with branches at or below three meters was made. In the group without branches two measurements were taken; the girth at the base and the height up to where the trunk of the tree measures 60 centimeters. In the group with branches below three meters, the girths at the base and at the place below the branch, the height of the appearance of the branch, the girths above the base of the branch, and the height from this point up to where the girth of the trunk measures 60 centimeters were measured. All the branches were measured in the same way as in the first group. Parts of a tree below 60 centimeters girth were not considered tappable. The trees are from a six-year old patch.

TABLE VI.—*Relation of forms of trees to tappable areas.*

No.	Girth at base	Height up to 60 cm. Girth	Mean Girth	Area
	cm.	*m.*	*m.*	*sq. m.*
1	107.8	6.24	83.9	5.226
2	113.9	5.18	86.95	4.504*a*
3	86.1	2.47	73.05	1.804
4	98.6	4.68	79.3	3.711
5	101.5	4.40	80.75	3.553
6	77.3	1.30	68.65	.892
7	90.7	2.87	75.35	2.163
8	110.5	5.62	85.25	4.791
9	70.2	.99	65.10	.644
10	82.1	2.01	71.05	1.428
11	93.8	3.98	76.9	3.061
12	103.7	3.90	81.85	3.192
13	111.3	6.44	85.65	5.516*b*
14	93.5	5.61	76.75	4.306*c*
15	100.0	5.27	80.00	4.216
16	95.2	5.30	77.6	4.113
17	91.4	5.89	75.7	4.459
18	94.4	4.26	77.2	3.289
19	100.1	6.09	80.05	4.875
20	113.0	6.53	86.5	5.640*d*
Sum	1935.1			71.391
Average	96.7			3.569

a) Branch at 5.18 m.
b) Branch 6.44 m.
c) Branch 6. 61 m.
d) Branch 4.65 m. Does not change on tapping outline trunk.

Examination of Table VII will show that branching trees are larger in girth than branchless trees, but the tappable area of the latter is greater. This is not the only undesirable result of branching. The branches throw the main trunk out of the erect position, so that both the branch and the trunk are inclining, thus making the tapping operation harder and more wasteful of latex. Branching trees claim more space, which of course is at the expense of their neighbors.

Any distance adopted must be that which will encourage the formation of a long, clean trunk. Branches formed after transplanting are to be dealt with shortly after their formation, leaving only the one which promises to be healthy and erect.

As soon as the desired trunk is formed it must be given more space to allow it to produce branches for the support of a more ample foliage which is necessary for the production and maintenance of a large body.

TABLE VII.

No.	Girth at base, cm.	Girth below branch, cm.	Ht. of branch, m.	Girth of trunk above branch, cm.	Ht. from branch to 60 cm. girth, meter	Girth of base first branch, cm.	Ht. to 60 cm. girth, meter	Girth base of 2nd branch, cm.	Mean of Girth of trunk below branch, cm.	Mean of Girth of trunk above branch, cm.	Mean of Girth of first branch	Tappable area of trunk below branch, sq. m.	Tappable area of trunk above branch, sq. m.	Tappable area of trunk above branch, sq. m.	Total tappable area, sq. m.
1	97.5	79.3	2.00	66.7	.75	55.7			88.4	63.3		1.768	.474		2.242
2	99.1	86.2	1.29	75.6	2.86	63.0	.26		92.6	67.8	61.5	1.194	1.194	.160	3.133
3	115.1	82.7	2.72	75.8	3.20	43.6			98.9	67.9		2.620	2.173		4.793
4	97.1	82.7	.26	67.4	1.72	63.0	.31		97.1	63.7	61.5	.252	1.086	.191	1.529
5	97.7	85.2	1.25	69.6	1.65	66.4	.32		91.4	64.8	63.2	1.142	1.069	.202	2.413
6	114.0	105.1	.72	78.0	2.25	63.3	.47		109.5	69.0	61.6	.788	1.552	.289	2.629
7	96.7	81.6	.80	59.3		61.7	.16		89.1		60.8	.713		.097	.810
8	106.6	89.8	1.51	76.7	2.24	56.5			98.2	68.3		1.483	1.970		3.453
9	75.6	73.2	.84	60.9	.23	50.8			74.2	60.4		.623	.139		.762
10	114.6	104.0	1.07	79.5	3.85	80.6	1.80		109.3	69.7	70.3	1.169	1.683	1.265	5.117
11	99.1	93.3	.48	66.3	1.68	51.8			96.2	63.1		.462	1.060		1.522
12	104.6	90.7	1.44	65.4	1.16	54.6		52.5	97.6	62.7		1.405	.727		2.132
13	86.8	73.9	1.50	58.7		58.9			80.3			1.204			1.204
14	114.9	88.3	2.07	73.4	3.37	61.9	.43		101.6	66.7	60.9	2.103	2.248	.262	4.613
15	107.3	78.4	2.22	66.7	11.19	52.9		37.4	92.8	63.3		2.060	.753		2.813
16	97.3	83.4	1.43	65.5	1.66	50.6	.17		90.3	62.7	60.3	1.291	1.040	.102	2.433
17	93.2	67.0	2.77	63.4	1.19	31.2			80.1	61.7		2.219	.734		2.953
18	93.6	74.2	2.57	60.6	.43	49.7			83.9	60.3		2.105	.259		2.364
19	88.9	73.2	1.83	62.3	.51	52.0			81.0	61.1		1.482	.312		1.794
20	124.7	118.1	1.35	69.3	1.62	75.1	2.02	64.3	121.4	64.6	67.5	1.639	1.046	1.363	*5.245
	91.8	86.4	1.10					.35	89.1		62.1			.217	
Sum.	2024.4														53.954
Ave.	101.2														2.697

*No. 20 has two branches, the one at 1.35 m. above the ground and the other at 1.10 m. above the first branch. 91.8 and 86.4 of Columns 2 and 3, respectively, are the girths after the first branch and below the second respectively, and 69.3 is the girth above the second branch. 0.35 of Column 9 is the height up to 60 cm. girth of the branch, 62.1 of Column 12 is the mean girth of second branch, and .217 of Column 15 is the tappable area of the second branch.

After the consideration of all points that may possibly bear upon the distancing, while no extensive careful investigation of the relation of yield to different distances, which should ultimately decide the distance to be adopted, has been made, the following is recommended as at least worthy of study.

The trees are to be planted in rows five meters apart, the trees three meters apart in the row. After five or six years the alternate trees in the rows are to be heavily tapped and cut down. Thus, trees standing in quincunx will remain at practically six meters apart. This distance will, it is believed, provide enough space to allow the trees to form a large crown which is necessary for the production and maintenance of large trunks. Trees of about 100 centimeters in girth standing alone in the open bear crowns of about six meters in diameter.

POSSIBILITY OF CASTILLOA RUBBER AS A FOREST PRODUCT

Castilloa rubber is a forest tree. Observations show that it will thrive and grow like any other forest tree under many conditions existing in the Philippine forests. The great number of seeds produced, the high percentage of germination and the fact that it is distributed through animal agencies, point to the possibility of its being distributed and naturalized in the Philippine forests. Its rapidity of growth and adaptability to varied conditions of climate and soil also point to the same possibility. And when it is considered that it has practically no enemies, it is easily conceivable that it would be only a matter of scientific sylviculture and governmental administration in order to have it distributed in our forests and become an important national asset within a not distant future.

TAPPING

In any rubber plantation tapping means one of the heaviest expense items. The solution of a satisfactory tapping system goes hand in hand with the solution of satisfactory cultural methods. A tapping system to be entirely satisfactory must extract the rubber at the least expense, cause the least injury to the tree and admit of easy retapping.

TAPPING METHODS

The earliest method employed in tapping wild Castilloa was naturally to cut or hew "steps in the tree for the ulero to climb up and extract the latex by making a series of cuts along the root." The following is a description of a method of tapping the trees in the forest of Nicaragua: "When the collectors find an untapped tree in the forest they first make a ladder out of the lianes, (*Calonyction speciosum*)* that hang from every tree. This they do by tying short pieces of sticks across them with small lianes many of which are as tough as cord. They then proceed to score the bark with cuts, shaped like the letter V, the point being downward; these extend nearly around the tree. A V-cut is made about every three feet all the way up the trunk. The milk will all run out of the tree in about an hour after it is cut and it is collected in a tin bottle made flat on one side and furnished with a strap to fasten onto a man's back. A decoction is made of liana and this on being added to the milk in the proportion of one pint to the gallon coagulates it to rubber, which is made into a round flat cake."

In the plantations, the methods of tapping differ quite a good deal, the tapping method being dependent mainly upon the readiness of the latex to flow.

**Calonyction speciosum* is more commonly known as *Ipomea bona-nox.*

The following is a description by Dr. Preuss of the method customary in the El Baul Plantation in Guatemala. (2)

"For tapping they use an instrument made out of a bush knife (machete). The end of the blade is for this purpose bent back until a groove is formed about broad enough to lay a finger in. The cutting edge of this groove is well sharpened. With this instrument the workmen tear horizontal gashes in the bark of the tree, and indeed over a half or three quarters of the circumference of the trunk. The grooves are cut at distance of 1½ feet one above another up to the principal branches. The milk at first flows out in drops, which fall to the ground. They let these go to waste because the quantity is only small and this milk is very watery. But in a minute or two the dropping ceases and the milk which then oozes is pulpy and remains in the furrows where it hardens into strips of rubber. In two days these strips are pulled out, washed, and dried in the shade and are then ready for market: Drying in the sun causes the rubber to become sticky and should be strictly avoided. The trees are tapped four times a year, each time another side of the trunk is operated on.

"The method used in Dominica (4) for tapping the Castilloa trees is very similar to that used in common in estates in Trinidad and Tobago. A thin chisel about 1½ inches wide is used. This is carefully tapped with a hammer, care being taken not to strike it too hard. The cuts are made in perpendicular rows about 8 inches apart, each row about 4 inches from the other. The second row is made in the interval between the first and the third. The latex which comes out in a fairly thick mass, collects around the cut, the accompanying black fluid flowing down the stem. The latex is then taken up with a spatula made of bamboo, put into small cups and transferred to earthenware vessels. In this way the trees are thoroughly tapped all round the tree stem in three or four operations. The trees may be tapped to any height, using a ladder for the purpose. The younger trees are operated only to a height of about 6 feet from the ground."

When the latex flows readily, double slanting cuts meeting at a point, so as to assume the shape of a letter V or its modifications, are in vogue. In this case "it was concluded that the most milk could be secured with the least injury to the tree by means of separate oblique incisions." (2).

In devising a tapping system* it would be necessary first to determine the nature of the flow and distribution of the latex, the nature of growth and removal of bark, etc.

The flow of latex.—When a cut is made on the bark of Castilloa a milk-like liquid immediately flows out. This is rather thin, about the consistency of ordinary milk, and in most cases drips to the ground. The amount of this is very small. Then a thick spongy mass oozes out of the cut slowly. This stays on the cuts. If the weather is dry this may be collected as dry rubber after two days.

Cuts made a few centimeters above or below the original cut one-fourth to one-half hour after the oozing has stopped cause practically no flow of latex. This shows that in Castilloa the latex issuing out of a cut is drawn from a certain area and that the flow of latex is not stopped by the coagulation of the latex on the wound as seems to be the case with Hevea. Cuts made by the side of the first cut do not show any reduction in the flow of latex, showing that no drainage takes place from the sides of a wound. Microscopic study has shown that the latex-containing vessels are small, slender tubes originating from the cambium. When these tubes are cut the latex is forced out, in spite of the capillary force which holds it in the tube, by mechanical compression exerted by the bark.

Movement of latex inside the bark.—Because plantation Hevea was the first to become commercially successful and consequently the more studied, it is natural that the ideas of the tapping methods with Hevea would be the first to be tried in the tapping experimentation of any other cultivated rubber trees. This is the case on Davao Gulf. The

*By tapping system is meant all the operations and instruments used in the extraction and collection of the latex.

multiple tapping using the V system and its modifications and the spiral system have been tried only to give way to the horizontal-cut, which is now adopted and which is superior to each of the other for use with Castilloa. The horizontal-cut method as adapted for rapid work, is the best position for holding the thick latex, and gives the least injury to the tree in proportion to the number of latex vessels cut.

A method tried on the gulf of Davao is: Beginning at the base of the tree the tapper with his knife and ladder makes cuts half way around the trunk and about 30 centimeters apart as high as he can reach with his ladder which is in proportion to the size of the trees. He then comes back to these trees two or three days after, collects his rubber and makes new cuts about four centimeters above the ones previously made. He continues this process until he finishes the tapping area or until the quantity of rubber obtained no longer pays. Then he taps the other side of the tree.

This system has a decided advantage as to economy in labor, since a tapper in visiting a tree to tap can gather his rubber at the same time, thus making a collecting visit unnecessary.

There is, however, one weak point in this system. Everyday experience shows that the amount of rubber collected grows less and less with every tapping and the drop in yield is very rapid.

Figures obtained from actual experiments performed in the following manner are given in Table VIII. Ten trees were tapped each with a cut 30 centimeters long and 90 centimeters above the ground. After three days five of the trees were tapped, again making two cuts, as long as before, one above and one below the first cut and four centimeters from it. After five days these five trees were tapped again in the same manner and also the remaining five in the same manner, thus giving eight days interval between the two tappings of the second five.

TABLE VIII.—*Effect of frequency of tapping on yield of rubber.*

No.	Girth in cm.	Yield dry rubber 1st tapping	Yield dry rubber 2nd tapping 3 days after 1st		Yield dry rubber 3rd tapping 5 days after 1st		Yield dry rubber 2nd tapping 8 days after 1st		% dry rubber 2nd tapping 3 days after 1st 100 %		% dry rubber 3rd tapping 5 days after 2nd yield of 1st 100%		% dry rubber 2nd tapping 8 days after 1st yield of 100%	
			Below	Above	Below	Above	Below	Above	Below	Above	Below	Above	Below	Above
1	47.6	2.7	1.1	1.4	0.7	0.4			40.74	51.85	25.92	14.81		
2	52.0	3.8	2.1	1.5	1.1	0.6			55.26	39.47	28.95	15.79		
3	54.1	7.5	3.2	3.4	2.1	1.6			42.67	45.33	28.00	21.33		
4	57.1	4.5	2.1	1.4	1.3	0.6			46.67	31.11	28.89	13.33		
5	58.0	5.6	2.6	2.9	1.0	0.8			46.43	51.79	17.86	14.29		
6	43.5	4.6					2.5	1.6					54.35	34.78
7	49.3	3.1					1.9	0.9					61.29	29.03
8	51.4	2.5					1.7	1.1					68.00	44.00
9	51.9	4.7					1.4	2.2					28.94	46.81
10	60.2	7.5					3.3	2.1					44.00	28.00
Average									46.35	43.91	25.92	15.91	51.31	36.52

It will be seen from Table VIII that cuts, made four centimeters from the previous cut after three days, yield dry rubber equal to from 40.74 to 55.26 per cent of that from the cuts below the first tapping, the average being 46.35 per cent and from the cuts above, from 31.11 per cent to 51.85 per cent, the average

being 43.91 per cent. The yield from the third tapping, made five days after the second, gave only from 17.86 per cent to 28.95 per cent, the average being 25.92 per cent of that from the cuts below; and from the cuts above only from 13.33 per cent to 21.33 per cent the average being 15.91 per cent. The cuts made after eight days gave from 28.94 per cent to 68.00 per cent from the cuts below and from 28.00 per cent to 46.81 per cent from the cuts above, the averages being 51.31 per cent and 36.52 per cent, respectively.

It is thus shown that a cut made near another after a very few days will yield less and less until a point is reached when the rubber obtained will no longer pay for the labor expended. Of course the same would be true, presumably to a more marked degree, when multiple tapping is employed as in Hevea.

The difference between the two plants lies in the fact that in the Hevea there is a tendency in the latex to move toward the wound while in the Castilloa there is no such tendency. This tendency in the former is known as "wound reflex" or "wound response" and is essentially a bleeding phenomenon.

The discovery of "wound response" in Hevea in 1897 stimulated its cultivation in the East and discouraged that of Castilloa as may be seen in the following interesting quotation. (4a)

"The demonstration of wound-response, therefore, placed Hevea in much more favorable position as a rubber producer, stimulating its cultivation. Before the discovery of this peculiarity, Hevea as a latex yielder in Ceylon did not look at all exceptional—in fact, it appeared less promising than Castilloa. From similar incisions made in untapped trunks of these two trees much more latex flows from Castilloa than from Hevea—roughly five to six times as much. But if after the lapse of one or two days fresh incisions are made in the trees quite near the old ones it will be found that from the Castilloa no latex or very little, oozes out, while from the Hevea about double the volume given by the first can be collected, and further this tree will continue giving this and even larger quantities for some time to come. Consequently a very much greater weight of rubber will be obtained in a year from a tree of Hevea than from one of Castilloa of a similar size. The yield from estates planted with these two trees bear this out in a striking manner."

It may be pointed out that the difference in yields of two trees belonging to two different families planted under the same conditions does not prove the correctness of the conclusion set forth above that the greater weight of rubber obtained from Hevea in a year is due to the existence of the phenomenon of wound response in the one and its absence in the other, for it is only possible and in this case very probable that the existing conditions are more favorable for Hevea than for Castilloa. It is a fact that agricultural crops differ in their requirements, and even in the same species and varieties some strains do better than others under certain conditions. Local experience is that Castilloa arrived at tapping size (60 centimeters girth at 90 centimeters from the ground) at four years of age and quite a number may be tapped at three years with very satisfactory yield, while Hevea is not tapped until eight years of age. It must also be remembered that the method of tapping found to be suited to Hevea is not suited to Castilloa and therefore the comparison of yield from each tapping of the two trees by the same method is anything but fair.

The absence of wound response in Castilloa, however, cannot be considered as an objection to it for plantation purposes as has often been stated, unless it can be shown that, other things being equal, the absence of wound response makes the cost of extracting a unit weight of rubber from Castilloa higher than that from Hevea. A comparison

of figures based on the yield of rubber per linear meter of cut would be very interesting.

The following information on Hevea is from Bulletin No. 12, Dept. of Agriculture, Ceylon: *Plot No. 870.* No. of trees, 25; average girth (inches), December, 1911—25; method, Half H. B. to left; fraction of circumference, one quarter; No. of cuts 4, 1 foot apart; tapping interval, alternate days; 1912, No. of tappings, 172; yield (grams) per tree, 842; percentage scrap, 16. Taking the circumference in 1911 as the basis of calculation and the angle of the cut to the vertical line as 45°, the length per cut is 8.83 inches and the length of all the cuts per tree per tapping is 35.32 inches; for 172 tappings, 6075.04 inches or 154.31 meters. The average yield per meter is 5.54 grams. The average of 20 Castilloa trees Table XVI Nos. 10 to 29 inclusive, is 11.00 grams per meter, the cuts being eight centimeters apart. And, as will be proved later, the yield per linear unit cut can be increased by increasing the distance between the cuts. Table XIII shows that the yield per unit cut at 25 centimeters distance is more than double the yield per unit cut at 10 centimeters distance.

YIELD *vs.* DISTANCE BETWEEN CUTS

It was demonstrated above that the latex issuing out of a cut is drawn from a definite vertical distance from each side of the cut. Therefore, between two horizontal cuts there is a distance where the yield of each is maximum and that as this distance is decreased the yield is also decreased, and as the distance is increased there is no more increase in the yield. It follows that the method of tapping for Castilloa is not to make cuts at or near the former cuts day after day but to determine the optimum distance and make all the cuts at once. In this way a great amount of labor will be saved by decreasing the number of unnecessary cuts and the prolonged injuring of the tree will be done away with.

To determine the distance most advisable to be put in practice a number of trees were tapped with cuts each 30 centimeters long one above the other and at different distances. The following tables give the results.

TABLE IX.—*Effect of distance between the cuts made in tapping on yield of rubber.*

No.	No. of cuts	Distance between cuts, cm.	Girth in cm.	Yield of dry rubber, cm.	Average per cut, gm.	Weight per m. gm.
1	50	2	59.4	32.1	0.64	2.13
2	25	4	61.3	38.8	1.55	5.16
3	17	6	53.0	31.4	1.85	6.16
4	14	8	53.0	45.1	3.22	10.73
5	11	10	64.5	43.2	3.92	13.06
6	10	12	52.9	35.7	3.57	11.90
7	8	14	51.0	30.9	3.86	12.86
8	8	16	72.8	25.3	3.16	10.53
9	7	18	52.1	17.5	2.50	8.33
10	6	20	61·9	31.8	5.30	17.66

There is a constant, although rather irregular, increase in the yield of dry rubber per unit cut as the distance between the cuts increases. To eliminate the irregularities that might be due to the difference in sizes another set of eight trees of about equal girths were tapped in the same way. Since yield of less than 10 grams of dry rubber per linear meter of cuts is not considered profitable, the least distance tried in this set was 10 centimeters.

TABLE X.—*Effect of wide space between cuts on yield of rubber*

No.	No. of cuts	Distance between cuts, cm.	Girth in cm.	Yield of dry rubber gm.	Average per cut gm.	Weight per m. gm.
1	11	10	74.1	36.5	3.32	11.07
2	9	12	74.0	51.3	5.70	19.00
3	8	14	71.6	29.1	3.64	12.13
4	7	16	66.9	36.8	5.26	17.53
5	7	18	62.5	42.9	6.13	20.43
6	6	20	70.0	42.3	7.05	23.50
7	5	25	69.7	32.2	6.44	21.47
8	4	30	67.0	36.3	9.07	30.23

It will be seen that up to 30 centimeters distance there is constant increase in yield per cut, proving that the maximum yield due to greater distance has not yet been passed.

In Table XI the rubber from the first and last cuts of Table IX was weighed separately from that of the middle cuts.

TABLE XI.—*Comparison of yield of rubber from upper and lower cuts and middle cuts.*

No.	Distance between cuts cm.	Girth cm.	No. of middle cuts	Weight of dry rubber 1st & last cuts gm.	Weight of dry rubber middle cuts gm.	Average per cut 1st and last gm.	Average per cut middle gm.	Weight per m. first and last cuts gm.	Weight per m. middle cuts gm.
1	10	74.1	9	13.8	22.7	6.90	2.52	23.00	8.40
2	12	74.0	7	23.7	28.1	11.60	4.01	38.66	13.37
3	14	71.6	6	12.6	16.5	6.30	2.75	21.33	9.16
4	16	66.9	5	17.1	19.7	8.55	3.94	28.50	13.13
5	18	62.5	5	23.2	19.7	11.60	3.94	38.67	13.13
6	20	70.0	4	20.8	21.5	10.40	5.37	34.67	17.90
7	25	69.7	3	17.3	14.9	8.65	4.97	26.83	16.57
8	30	59.4	3	14.2	15.6	7.1	5.2	35.5	26.0*

*Length of cut 20 cm.

Table XI shows that the yield of dry rubber per unit cut of the first and last is more in all cases then the yield per unit of the middle cuts, and that up to 30 centimeters distance the average per cut of the first and last is 1.9 grams, or 26.76 per cent, over the average of the middle. This is because the first and last cuts are able to draw latex from a greater distance than the middle cuts. It proves that the latex issuing out of a cut comes from much further than 15 centimeters from each side of the cut.

The fact that the yield of rubber can be increased with the increase of distance between the cuts is a decided advantage in favor of Castilloa, since the cost of labor can be reduced by increasing the distance.

In actual practice with the present cost of labor, yields of less than 10 grams of dry rubber per linear meter of cut are not considered profitable. The average yield per meter of the middle cuts is over 10 grams at the distance of about 16 centimeters and since when a number of cuts are made, say as high as four or five meters above the ground, the difference in the average yield between the first and last cuts is insignificant, in actual tapping the distance should not be less than 16 centimeters.

On the other hand it may be concluded that the greater the diameter the better, and that the distance should not be less than 30 centimeters. But it must be expected that the amount of rubber not extracted also increases with the increase in distance. How far this is true is shown in Table XII. The figures represent the dry rubber obtained from the second tapping a week later, the cuts this time being made midway between the cuts of the previous tapping.

TABLE XII.—*Yield of rubber from second tapping between original cuts*

No.	Distance between cuts cm.	No. of cuts	Weight of dry rubber, gm.	Average per cut	Weight per meter gm.
1	10	10	3.5	.35	1.16
2	12	8	7.2	.90	3.00
3	14	7	3.9	.56	1.86
4	16	6	6.3	1.05	3.50
5	18	6	5.4	.90	3.00
6	20	5	6.4	1.28	4.26
7	25	4	5.5	1.37	4.56
8	30	3	7.5	2.50	8.33

In order to eliminate the irregularities in increase of yield due to unequal sizes and to individual variations, three large trees were tapped in the following manner: Each was divided into three sections. On the first tree each section was tapped at distances of 10, 12, and 14 centimeters respectively; on the second at distances of 14, 16, and 18 centimeters; and on the third at distances of 18, 20, and 25 centimeters. Each cut was 20 centimeters long. Results are given in Table XIII

TABLE XIII.—*Comparison of yields of different spacing of cuts on the same tree.*

No.	No. of cuts	Distance between cuts. cm.	Girth cm.	Yield dry rubber gm.	Ave. Wt. per cut gm.	Area square dm.	Wt. extracted per square dm.	Per cent increase of yield first 100 %
I	11	10	11.6	30.6	2.78	20.0	1.53	100.
	9	12	11.6	28.2	3.13	19.2	1.47	112.59
	8	14	11.6	26.6	3.32	19.6	1.36	119.42
II	8	14	87.5	34.0	4.25	19.6	1.73	119.42
	7	16	87.5	27.3	3.90	19.2	1.42	109.58
	7	18	87.5	32.1	4.59	21.6	1.49	128.97
III	7	18	99.2	21.4	3.06	21.6	.99	128.97
	6	20	99.2	26.8	4.47	20.0	1.34	188.40
	5	25	99.2	26.7	5.34	20.0	1.33	225.06

The yield per cut at the distance of 25 centimeters is 225 per cent, or more than double the yield per cut at 10 centimeters distance. The yield per square decimeter decreases very slightly as the distance between the cuts increases.

VARIATION OF YIELD AT DIFFERENT HEIGHTS

It is an everyday experience with the tappers that more rubber is obtained from the lowest cuts. Hence, their tendency is to make the first cuts as low as possible. In the case of Hevea the flow of latex at high level is considered unprofitable, so that tapping is limited to the basal two meters. In the case of Castilloa, however, tapping is done as high as possible and with older trees tapping up to six meters is not uncommon.

Table XIV shows the difference in yield of dry rubber between the tappings at the bottom and at three meters above the ground on the same side of the tree. In each case there are five cuts each 20 centimeters long and 30 centimeters apart. Thus the total length is one meter. The second girth is taken at the third cut or 3.6 meters above the ground.

TABLE XIV.—*Yield of rubber from cuts of different heights of trees*

No.	Girth 90 cm. above ground cm.	Yield dry rubber bottom tapping gm.	Girth 3.6 m. above ground cm.	Yield dry rubber high tappin gm.	Difference in yield of dry rubber gm.
1	59.0	20.2	46.0	10.7	9.5
2	50.2	17.1	44.0	4.5	12.6
3	65.0	38.6	59.8	22.6	16.0
4	59.7	23.6	51.5	12.1	11.5
5	60.1	31.4	42.7	10.2	21.2
6	52.7	26.6	42.9	14.2	12.4
7	51.5	15.7	37.5	8.1	7.6
8	55.2	16.2	42.7	10.3	5.9
9	59.4	31.5	48.7	19.2	12.3
10	58.6	28.7	51.1	13.9	14.8
11	73.7	32.6	61.2	21.5	11.1
12	68.6	26.4	56.4	17.4	9.0
13	66.8	19.4	51.4	13.7	5.7
14	112.9	59.3	68.4	45.7	13.6
15	66.5	38.9	53.3	27.5	11.4
16	60.6	35.4	53.2	15.4	20.0
17	71.8	38.8	62.7	15.4	23.4
18	76.2	36.2	61.9	23.3	12.9

In numbers 1 to 10 inclusive the decrease in the yield at high tapping is due to at least two causes: (1) the tapping at the bottom was done in the morning and that at three meters in the afternoon; (2) the lactiferous system is not yet fully developed at the place where the high tapping was made, as is shown by the small girths. These two points will

be proved later. In numbers 11 to 18, inclusive, tapping was made at the same time and the decrease in the yield of the high tapping is not so much as in the first ten in proportion to the yield of the bottom tapping. Besides, the girths at which high tapping was made in most of the trees of the last numbers are already of tappable size. Another reason which will partly account for the difference in all cases is the difference in root pressure, as this is greater the nearer to the bottom. In the case of Hevea it has been recently discovered that the rows of latex vessels increase in number toward the bottom; this may be the case also with Castilloa. (6)

VARIATION OF YIELD AT DIFFERENT TIMES OF THE DAY

Since the latex is forced out of a cut by pressure, it is only to be expected that the latex oozing out of a cut will vary as the pressure inside the tree varies. Pressure inside the tree is greater when root-pressure is most active. In the case of Castilloa this pressure is especially great early in the morning, as may be seen by water exuding from a cut which has removed part of the wood. The water is absent when transpiration is active. Transpiration approaches its highest as the day approaches its highest temperature. Personal experience with coconuts has shown that transpiration is maximum between two and three in the afternoon and it is logical to assume the same to be true of Castilloa in the open, since the governing factor is the same. It is therefore to be expected of Castilloa that the yield of rubber per unit cut, the distance remaining the same, will be more in the early morning just before transpiration sets in than at noontime when transpiration is in active function.

To find out how far this difference in pressure may be reflected by the yield of dry rubber, ten trees were tapped at six in the morning, each tree receiving five cuts 20 centimeters long and 30 centimeters apart. At noon the same trees were tapped in the same manner on the opposite side. The weather was very favorable for the experiment, being clear the whole day. The results are given in Table XV.

TABLE XV.—*Yield of rubber from tapping at different times of day.*

No.	Girth cm.	Yield dry rubber in gm. morning tapping	Yield dry rubber in gm. noon tapping	Difference	Per cent decrease
1	52.7	26.6	21.4	5.2	19.54
2	54.2	17.1	11.2	5.9	34.50
3	51.5	15.7	9.8	5.9	37.58
4	55.2	16.2	10.8	5.4	33.33
5	58.6	28.7	22.5	6.2	21.60
6	59.0	20.2	14.6	5.6	27.72
7	59.7	23.6	16.3	7.3	30.51
8	60.1	31.4	17.4	14.0	44.58
9	59.4	31.5	26.5	5.0	15.87
10	65.0	38.6	27.9	10.7	27.72

The tapping at noon decreases the yield of dry rubber by from 15.87 per cent to 44.58 per cent, the average being 29.29 per cent.

Therefore, tapping should be done as early in the morning as possible and finished before the hottest part of the day.

Locally this arrangement has another advantage. As was stated above, most of the rains occur in the night. Tapping done in the morning, say up to 11 o'clock, gives the latex at least five or six hours to coagulate. This time has been repeatedly observed to be enough even in cloudy weather to allow the latex to assume such a condition as to be left intact by the hardest rain that may be expected.

The arrangement of the leaves of Castilloa prevents the rain from exerting its full force so as to do much harm to the uncoagulated latex. Actual observation shows that the arrangement of the broad leaves is in effect practically the same as a thatched roof and very little water flows along the side of the trunk. In the

case of perfectly erect trees this flow is minimal. In inclined trees the water dropping from the tips of the leaves may fall on the exposed surface of the trunk.

AGE TO TAP

The age at which tapping may be begun in Castilloa varies a good deal in different places and recommendations have been made varying from six to twelve years, although eight to ten years seem to be the most common. In most cases size, rather than age, governs the time of tapping.

It is well known that rubber from young trees is more resinous and weaker than that of older trees. Rubber is in so weak a state as not to be very easily collected up to the age of about two years. But at the age of three years rubber is already of such strength as to stand the jerk of pulling without breaking during collection. Since tapping on Davao Gulf and, probably elsewhere, is not begun before the age of three years, this is not a factor in determining the age of tapping.

It has been observed that tapping on young trees does not give as copious a flow of latex as in older trees. The question arises as to whether the latex continues to be stored in the bark as the tree grows older or whether it continues to increase in quantity per unit of area of the bark only up to a certain size. Experience proves that it cannot be stored in bark, otherwise in cases of large untapped trees the flow of latex would be so great that it could not be held on the cut and would drip to the ground. But the drip of latex to the ground, as daily observed, does not have any relation to the size of the tree.

The size at which the amount of latex per unit of area is maximum is certainly the best time to begin the tapping.

To determine this size a number of trees of varying sizes were tapped. Each received thirteen horizontal cuts each cut twenty centimeters long and eight centimeters apart, thus the latex was extracted from equal areas. The distance of eight centimeters was adopted because previous experiments show that it practically extracts as much rubber per unit of area as any shorter distance.

It has been repeatedly stated in the case of Hevea that the thicker the bark the greater is the yield of rubber. It seems, however, that this is pure assumption and has not yet been demonstrated. To find out how far this may be true with Castilloa the thickness of the bark of all the trees has been measured.

The results are given in Table XVI.

TABLE XVI.—*Effect of thickness of bark and girth on yield of trees.*

No.	Girth cm.	Weight of dry rubber grams.	Thickness of bark mm.
1	28.5	8.1	3.5
2	33.7	14.1	4.5
3	38.5	14.4	5.0
4	44.1	18.8	5.0
5	44.2	19.6	6.0
6	45.5	19.3	5.5
7	47.0	16.6	6.5
8	49.3	23.6	6.5
9	49.9	18.0	6.5
10	55.3	31.8	7.0
11	56.1	23.1	7.0
12	58.0	20.2	6.5
13	62.0	29.5	7.5
14	65.4	27.9	8.0
15	66.9	18.6	7.0
16	68.6	48.0	7.5
17	69.6	31.3	9.0
18	73.6	33.6	8.5
19	73.8	48.3	8.0
20	74.3	26.4	7.5
21	78.7	23.5	8.0
22	82.3	23.5	9.5
23	89.9	29.0	8.5
24	90.1	33.8	10.0
25	94.4	35.9	9.0
26	94.7	21.9	9.5
27	104.4	25.2	10.5
28	114.5	39.8	10.5
29	123.9	21.9	11.0

There is a constant rise in the yield of dry rubber per unit of area until the girth of about 55 to 65 centimeters is reached. After this the fluctuation is due to in-

dividual variation and other causes, as shown by the absence of a general tendency to increase in yield. Number 15 has weak rubber and since the practice is to cut down trees producing weak rubber this should not be considered in interpreting the results. Numbers 21 to 29, inclusive, except Number 23, are in abaca plantations where the soil is light clayey loam. All the rest are from a patch with very fine sandy loam soil.

For a better interpretation of results, the trees are grouped into different measures of girth of 25-35 centimeters, 35-45 centimeters, etc., and the average for each group taken. The thickness of the bark is computed in the same way. Curves* are constructed from the average obtained. Number 15 is not included in the computation.

*Omitted in publication.

TABLE XVII.—*Comparison of yields of rubber of trees of different girth groups*

	25-35	35-45	45-55	55-65	65-75	75-85	85-95	95-105	105-115	115-125
Average girth.....	31.1	42.3	49.4	58.7	70.9	80.5	92.3	104.4	114.5	123.9
Average weight.....	11.1	17.6	21.9	24.4	35.9	23.5	30.2	25.2	39.8	21.9
Average thickness of bark	4.0	5.3	6.4	7.0	8.1	8.7	9.2	10.5	10.5	11.0

The high point in the curve between 65 and 75 is due to Numbers 16 and 19 of Table XVI which are extraordinarily good yielders. The general trend of the curve however shows the tendency to become flat after girth of 60 centimeters. After 100 each point is represented by only one tree.

There is no definite relation that may be ascribed to the thickness of the bark and yield of rubber. Its increase in thickness is paralleled by the development of the lactiferous system until the tree reaches the girth of about 60 centimeters, after which it continues to increase in thickness without necessarily increasing the yield of rubber.

THE BARK

An understanding of the nature of the growth and distribution of the latex vessels in the bark is of fundamental importance in connection with tapping. The study of the minute anatomy of the bark is essential for such an understanding. In the absence of facilities for this kind of work attempts were made to learn as much as possible with the naked eye.

Distribution of the latex vessels.—On cutting a young Castilloa tree it will be seen that the latex exudes in a rather considerable quantity from the region of light green tissue immediately next to the pith, in small quantities from different places in the wood and in a large quantity from the bark. It is the last that is extracted directly by tapping.

The greenish tissue around the pith is connected with the bases of the branches. When the branches fall and the bark is formed over the marks left, there is a direct connection between the bark and this tissue. It would be of great interest to know to what extent the latex in the wood and this greenish tissue can carry on the function required of the latex, if the latex in the bark was removed. An experiment performed by Mr. H. S. Peabody, General Manager of the Lais Trading and Development Company, with trees scored with very many cuts close to each other and encircling the trees, showed that not only is the tree able to recover but it remains as healthy as ever, thus leading him to the conclusion that "Castilloa cannot be killed by tapping."

The distribution of the latex vessels in the bark as shown by the exuding latex can be separated in two distinct sections. The first section includes the cambium and the comparatively young soft tissue immediately next to it. This section is separated from the second outer section by a more or less distinct outline, but always clear enough (in all that have been studied) to the naked eye to admit of accurate measurement of the thickness of the section. (Bark specimens were put in 75 per cent alcohol to extract and coagulate the latex before measurement.) The second section includes the older tissue between the first section and the corky layer outside. It contains a very small quantity of latex in comparison with the first. It has an irregular outline on the outside, since the cork formation has already advanced at points sending out wedge-shaped projections piercing this section. It will thus be seen that in order to extract the greater bulk of the latex the first section must be cut, at least partially.

It has been shown above that the yield of rubber per unit of area increases as the circumference of the tree increases up to about 60 centimeters, after which the fluctuation in the yield is already due to individual variation and other influences.

Measurements of the first section show that it increases in thickness until the tree attains a girth of about 65 centimeters after which it remains more or less constant. Table XVIII gives the results.

The thickness of that section when fully developed is from 2.75 to 3 millimeters. Hence tapping must always be deep enough to be within three millimeters of the wood.

Renewal of bark.—It has been stated time and again that when the cambium is not cut no new bark appears, and that the best bark renewal is attained when

TABLE XVIII.—*Comparison of girths with total thickness of bark and with the thickness of rubber-yielding bark in Castilloa.*

No.	Girth	Thickness of bark	Thickness of first section
	cm.	mm.	mm.
1	13.8	3.0	1.00
2	23.4	3.0	1.00
3	26.7	4.5	1.00
4	38.7	5.0	2.50
5	39.7	5.0	1.75
6	44.9	7.5	2.00
7	50.7	6.0	2.50
8	58.7	8.0	2.50
9	61.4	8.0	2.50
10	64.3	7.5	2.75
11	75.9	6.5	2.00
12	78.0	8.00	3.00
13	84.7	8.5	2.75
14	90.0	10.0	2.75
15	90.9	10.0	3.00
16	92.9	8.5	3.00
17	102.1	9.0	2.75
18	111.1	11.0	3.00
19	112.3	10.0	3.00

the cambium is cut somewhat; that in the latter case the bark grows rapidly so as to be on the same level with the old bark, while in the former the outside bark simply hardens. As a matter of fact, when the cambium is not cut, the outside tissue which is more or less bruised by the tapping instrument dries up, but the bark continues to grow although slowly and to maintain the three millimeter section of the latex-bearing tissue. The outside surface of the bark is harder than the formation after the cambium is cut because the cork tissue is older. When the cambium is cut new bark is put on and grows in thickness up to the same level as the old bark. But in the same way as before, the three millimeter section of the latex tissue is constant, and the extra bark put on is corky tissue. In many cases the raising of the new bark to the level of the old bark is not entirely due to its rapid growth but to the formation of woody knobs as a result of cutting the cambium. This behavior of the bark of Castilloa has been personally observed not to be

characteristic of it alone. When Hevea is tapped in the same way, exactly the same thing takes place. When the cambium is cut, new bark is put on in the same way, and when the cambium is left intact the surface hardens and the growth is slow.

Table XIX gives the measurements of the latex section of the bark from trees that have been tapped. Samples were taken from the place where new bark has appeared so that it consists of half new bark and half old bark. Measurements of thickness were taken on the old bark part. The same was done with the latex section.

TABLE XIX

No.	Girth cm.	Thickness of bark mm.	Thickness of latex section mm.
1	86.8	13.0	2.50
2	89.9	14.0	3.25
3	66.2	9.5	3.00
4	75.5	11.5	3.00
5	87.0	11.5	2.25
6	81.9	9.5	2.00
7	106.5	10.5	3.75
8	105.8	15.0	2.50
9	79.8	11.5	2.75
10	107.8	14.0	3.00
11	53.7	8.0	3.00
12	69.5	12.0	1.75
13	102.9	14.5	3.00
14	75.4	10.5	3.00
15	97.2	12.5	3.50
16	78.6	9.5	3.00

The bark becomes harder and thicker as the tree gets older; and when the tree is being tapped the hardening and thickening of the unremoved bark is much more rapid. In order to maintain the ease of tapping the system must be such as to allow the tapping of young bark all the time. A system of multiple tapping, like that employed in Hevea, will automatically remove the older outer part of the bark and hence every next tapping cuts young bark.

With Castilloa, tapping can be done at certain regular intervals on old tappings. Experiment shows that as much rubber can be obtained when tapping is done on the old bark as when it is done on the new bark. This is because the new latex layer extends continuously through the new bark. In fact a cut made above the new bark drains the latex from below it.

Table XX gives the results of a tapping made on old bark immediately above the new bark and on new bark. In interpreting the results it must be borne in mind that many of the trees are not yet of the tapping size and that the new bark was still very young.

TABLE XX.—*On old bark above new bark*

No.	Dist'ce of 1st cut from ground cm.	Average dist'ce bet. 'n cuts, cm	No. of cuts	Girth cm.	Weight of dry rubber	Weight per meter
1	26	26	4	51.7	6.5	8.1
2	24	30	4	36.4	8.0	10.1
3	22	30	4	52.9	7.7	9.6
4	16	30	4	52.3	4.0	5.0
5	28	22	4	57.0	6.4	7.6
6	31	27	4	61.5	9.7	12.1
7	21	33	4	63.4	10.0	12.5
8	27	24	4	36.2	5.5	6.9
9	21	31	4	49.2	6.2	7.7
10	30	25	5	51.6	6.7	6.7
	Average			51.1		8.6

On new bark

No.	Dist'ce of first cut from rubbers	Average distance between cuts	No. of cuts	Girth in cm.	Weight of dry rubber gm.	Weight per meter gm.
1	21	17	5	48.3	10.3	10.5
2	50	16	4	34.9	5.0	6.2
3	51	23	4	48.9	6.8	8.5
4	29	25	5	37.6	6.5	6.5
5	30	34	4	54.0	3.6	4.5
6	17	31	4	72.3	11.3	14.1
7	28	25	5	60.4	11.9	11.9
8	29	22	5	48.8	4.5	4.5
9	20	17	4	61.0	5.7	7.1
10	22	23	4	44.1	6.7	8.4
	Average			51.0		8.2

TAPPING KNIVES

Tapping knives of various kinds and constructed on different principles have been tried, but none was found to be satisfactory. A modification of a Farrier knife was developed. It is 30 centimeters long, including the handle, which

is 20 centimeters long. The metal part is two centimeters broad and about one millimeter thick, curved so as to place the cutting edge about four centimeters from the straight line from the handle. The end is bent sidewise forming a groove four millimeters wide, the angle being about 30° to the handle.

It is easily handled by the ordinary farmer and the length of the handle enables the tapper to use one or both hands, as he may see fit. It is easily adjusted to the varying ways of handling which arise with the use of a long ladder. It is light, strong, and easily sharpened with a round-edge triangular hone.

THE LADDER

A ladder is part of the equipment of a tapper. A well made ladder is of great importance for his efficiency. The ladder should be light and strong, and as for every block of different age a ladder adapted to the size of the tree is needed, it must be easily made and the material must be cheap. Very slender and straight bamboo are used, which may be as long as six meters. Cross pieces are of smaller bamboo or strong wood. The width of the ladder is about 30 to 50 centimeters narrowing slightly toward the top. The last cross-piece at the top of the ladder is a bent piece of wood that fits the convex surface of the tree, thus preventing the sliding of the ladder while the tapper is at work. A ladder of this kind can be made in from two to three hours including the time spent in getting the material and will serve for three months or longer.

SUMMARY AND CONCLUSIONS

1. The extreme success that Hevea has attained has led to the impression that Castilloa can not be successful anywhere in the East. That there are places where it can be successfully exploited is proved at least by the Castilloa plantations in the regions around the gulf of Davao, if by no others.

2. The Philippines lie entirely within the latitudinal range of the natural distribution of Castilloa.

3. Because of the ease of cultivating it and of the practical absence of natural enemies together with the simplicity of extracting and preparing rubber from it, Castilloa is an ideal crop for the uneducated inhabitants of the wildernesses of Mindanao.

4. It does not shed its leaves at one time, although in the months of September, October and November most of the leaves are shed and a few trees may be seen entirely leafless and bearing fruits heavily. Fruits are borne by some trees throughout the year.

5. Birds and wild chickens and bats eat the fruits and in that way distribute the seeds.

6. Castilloa does best in full sunlight. This condition produces short, thick and early branching. When grown under rather crowded conditions it forms a long slender and branchless trunk.

7. It succeeds in competition with "parang" or second-growth trees. It will thrive in comparative neglect on grass and cogon land, if soil conditions are favorable.

8. The greatest growth in girth under plantation conditions takes place during the first two years. After that it continues at the rate of about 9 centimeters a year.

9 It grows best in open, porous soil, because this soil is naturally well drained. In heavy clay soil it will do as well if perfect drainage is assured.

10. Great variation exists both in growth and yield of dry rubber per unit of area of the bark. The best yielder is the tree with a rapidly tapering trunk and large conical crown.

11. Forking increases the bottom girth of the tree but it throws the trunk out of the erect position and also reduces the tappable area.

12. While a rather close planting is advisable, it should not be allowed to remain under this condition after six or seven years. More space should be given the old trees.

13. Multiple tapping is not the method for Castilloa. It will result only in much waste of labor and unnecessary injury to the tree.

14. Tapping should be done at once on one side of the tree as high as the tappable girth with equal distance between the cuts.

15. The absence of "wound response" cannot be considered a disadvantage of Castilloa. It only calls for a different system of tapping.

16. The yield of dry rubber per unit cut at equal distances decreases with the height of the cut on the trunk.

17. The yield of dry rubber per unit cut is greater in the morning than at noon when transpiration is in active progress and root pressure is absent.

18. Time for tapping should be determined by size rather than by age. Tapping can be begun when the tree reaches a girth measure of 60 centimeters at 90 centimeters above the ground.

19. There is no relation between the thickness of the bark and the yield of dry rubber per unit of area.

20. Tapping cuts should be deep enough to be within three millimeters of the wood.

21. Retapping can be done on old cuts after certain intervals.

ACKNOWLEDGMENT

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The following important paper was received too late for reference in connection with above work.

Roepke, W. and Peelen, J. C. R. Die Castilloa-Kultur auf Java. Rubber Recueil, Batavia. 1914.

The Effect of Natural Fertilizers on the Production of Tobacco *

By Nemesio M. Hernandez

One of the important problems in connection with the cultivation of tobacco is the use of fertilizers. The purpose of the present article is to report the results of experiments dealing with the effect of natural fertilizers on the quantity and quality of tobacco leaf.

Methods

Plan of the experiment

Thirteen plots of 10 by 25 meters each were laid out side by side separated by a path one meter wide. Three plots were controls. To each of the remaining ten was applied a different fertilizer. The fertilizers and the combinations were as follows: horse manure; ash and horse manure; compost and horse manure; vines and horse manure; ash; compost and ash; vines and ash; compost; vines and compost; vines.

DIAGRAM OF PLOTS

1	2	3	4	5	6	7	8	9	10	11	12	13
Control	Horse manure	Ash and horse manure	Compost and horse manure	Vines and horse manure	Ash	Control	Compost and ash	Vines and ash	Compost	Vines and compost	Vines	Control

*Thesis presented for graduation from the College of Agriculture, No. 102; Experiment Station Contribution No. 11.

The main object of this work was to observe the effect of the different natural fertilizers on the growth qualities and yield of the leaf of the different varieties of tobacco.

The soil and its preparation

The soil used for this experiment was level and had never been fertilized. Previous to this experiment the field had been planted to corn. The soil was uniform in texture, being light loam.

The preparation of the soil was begun September 2, 1918. On account of the unfavorable weather conditions the second plowing of the field was postponed until October 22, 1918. After the second plowing the soil was harrowed; then furrows 75 centimeters apart were made across the plots.

Application of manure

The manures were put in the bottom of the furrows and covered with soil. The horse manure when applied was thoroughly fermented and the legume vines were cut into small pieces before laying them in the furrows. The compost applied was thoroughly decayed.

Table I shows the kinds of natural fertilizers used, the amount applied and the value per hectare.

Table I.—*Amount and value of natural fertilizers used.*

Kinds of fertilizers.	Amount per hectare.	Value per hectare.
	Kg.	
Horse manure	15,000	₱18.00
Horse manure + ash	15,000+2,120	22.40
Horse manure + compost	15,000+14,760	22.40
Horse manure + vines	15,000+30 cartloads	26.80
Ash	2,120	4.40
Ash + compost	2,120+14,760	8.80
Ash + legume vines	2,120+30 cartloads	13.20
Compost	14,760	4.40
Compost + legume vines	14,760+30 cartloads	13.20
Legume vines	30 cartloads	8.80

Results in the third column include cost of hauling and applying only, the fertilizers being secured free. The place from which the horse manure was taken was at a distance one and one-half kilometers from the College. Legume vines, compost and wood ash were obtained on the College premises.

The cost of hauling the fertilizers was computed on the following basis.

HORSE MANURE.—Two day-laborers, wages ₱0.90 a day, hauled four cart loads in one day.

COMPOST, ASH AND LEGUME VINES.—One day-laborer, wages ₱0.90 a day, hauled four cart loads in one day.

VARIETIES OF TOBACCO USED

The varieties of tobacco used in this experiment were Broad Leaf, Echague, and Romero. All these varieties are newly introduced in the College.

The seedlings which the writer used in this experiment were grown by Pedro David for his thesis. These tobacco seedlings, according to the work of David's thesis, were grown under different treatments of fertilizers. The fact that the aim of this work was to observe the behavior of natural fertilizers on the growth of the tobacco both on quality and yield, effort was made to select seedlings grown under natural fertilizers and control.

TRANSPLANTING AND CARE

The transplanting of young seedlings was begun October 26, and finished October 29, 1918. The work was done early in the morning and late in the afternoon. Only healthy and uniform seedlings were selected and planted. The distance apart of the plants in the rows was 50 centimeters. The newly planted seedlings were watered every day and shaded with pieces of banana sheaths on the hot days. Cultivation, or the loosening of the ground around the plants, was done mostly with "dulos" used by women laborers. This native implement was used for weeding at the same time.

DISEASES AND PESTS

It was observed that bud worms, cut worms, crickets, and green grasshoppers appeared a few days after setting the young seedlings in the field. To keep the plants free from these enemies efforts were made to gather and destroy the pests. The diseases observed in the field were bacterial wilt, leaf spot and mosaic.

TOPPING AND SUCKERING

The plants were topped soon after the flowers appeared. The object of this operation is to allow the leaves to spread and to attain the proper body and thickness. But topping should be carefully done or it may result in producing an undesirable product. One author recommends the following, "A slow growing plant should not be topped as high as a rapid grower. The former will not mature as many leaves as the latter. For the same reason, plants grown on poor soil should not be topped as high as those grown on rich soil." (10) The number of leaves a plant has should be taken into account also; planters in different countries have different ideas about topping the plants.

In this experiment a few days after topping, the plants developed auxiliary shoots called suckers. These were removed when from two to four inches long. Suckers should not be allowed to remain on the plants, for the food materials that would go in the production of the leaf go into the sucker, and the object of topping will not have been accomplished. Large suckers do not only exhaust available food material of the plant but they also cause the leaves to break off from the plant, and leave a scar which sometimes favors the growth of fungus.

HARVESTING, POLING AND CURING

Priming was the method used in harvesting. The harvesting began January 16 and lasted until February 27, 1919. The fresh leaves taken from each variety in a plot were weighed and then poled. The method of poling was that used in Cuba, that is the leaves were strung side by side on a pole about two meters long. The poled leaves were allowed to cure on the curing racks in the tobacco house and then were weighed.

RESULTS AND DISCUSSION

COMPARATIVE RESULTS FROM FERTILIZED PLOTS

The stand.—Judged by the vegetative growth of the three varieties of tobacco used, the effect of legume vines and horse manure ranked first and second, respectively. This effect is primarily due to the fact that both fertilizers contain beneficial constituents such as nitrogen, one of the most essential requirements of the tobacco plant in attaining a maximum development. The plants grown in plots where these two fertilizers were used were vigorous, healthy, and almost uniform in height.

Ash, on the other hand, had the least effect on the growth of the three varieties of tobacco used. The plants grown in plots where this fertilizer alone was used were stunted in growth. But wherever ash was mixed with other fertilizers, such as horse manure, legume vines and compost, its effect on the growth of the plant as shown in Table II ranked as intermediate.

Compost alone and some of its combinations such as legume vines and horse manure also gave an intermediate effect on the growth of the three varieties of tobacco used.

During the period of development of the plants, effort was made to observe the size and the texture of the leaves of the three varieties of tobacco grown with different treatment of fertilizers. The varieties Broad Leaf and Echague grown in plots fertilized with legume vines, horse manure, the combination of horse manure and legume vines, or ash and legume vines, produced long, broad, medium thick and dark leaves. All the three varieties grown where ash alone was used gave the poorest result.

Table II shows the comparative results of the different natural fertilizers on the vegetative growth of the different varieties of tobacco.

TABLE IV.—*Effect of fertilizers on vegetative growth.*

Cul. No.	Kinds of Fertilizers.	Broad Leaf.			Echague.			Romero.		
			Size of Leaf.			Size of Leaf.			Size of Leaf.	
		Height	L.	W.	Height	L.	W.	Height	L.	W.
		cm.	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
1, 7, 13	Control.....	138.54	49.5	27.5	132.82	46.3	25.8	128.56	37.5	23.8
2	Horse manure..	153.43	61.9	38.2	148.55	56.5	34.5	142.23	47.9	30.5
3	Horse+ash....	146.76	54.8	30.5	140.53	48.2	29.9	135.00	33.7	24.2
4	Horse+compost	148.65	55.7	31.4	134.30	50.7	31.3	140.50	38.5	26.5
5	Horse+vines...	150.45	57.3	32.3	138.76	52.9	32.8	132.32	33.9	24.8
6	Ash.....	133.40	46.3	26.7	125.85	40.3	24.2	120.57	30.5	20.5
8	Ash+compost..	142.75	48.2	27.2	136.35	46.8	26.5	130.45	32.2	22.8
9	Ash+vines.....	147.63	58.3	33.8	130.78	50.9	30.8	129.85	32.9	22.9
10	Compost	144.38	53.5	30.7	135.43	49.8	28.4	132.34	33.1	23.4
11	Compost+vines	140.53	50.2	30.3	136.95	48.5	28.0	135.85	33.5	22.5
12	Vines.....	163.43	66.5	39.2	157.85	60.5	37.5	133.25	34.8	25.2

Cost of Operation.

Preparing the ground including pest control and harvest (Computed per hectare)	₱262.80
Application of manure	8.80
TOTAL INVESTMENT	271.60
Market price of tobacco per kilo	0.22
Income or value of production per Ha. based on Broad Leaf grown in legume vines	451.72
TOTAL INVESTMENT	271.60
GAIN ON THE INVESTMENT	150.12
Income or value of production per Ha. based on the same variety in control	337.91
TOTAL INVESTMENT	262.80
GAIN ON THE INVESTMENT	75.11

The following shows the increase in the production due to manuring:

Gain in Production per Ha. due to manuring	180.12
Gain in production per Ha. in control	75.11
Gain in production per Ha. over the control	₱105.01

It should be borne in mind that this comparison of yield of Broad Leaf variety, is based upon two plots only, one of which was the control and the other was fertilized with legume vines.

Table III shows the comparative results of manuring on the yield of the different varieties of tobacco.

TABLE III.—*Effect of Fertilizers on Yield.*

Kinds.	Yield of cured leaves: Yield per plant in kg. ave.	Yield of cured leaves: Yield per ha. in kg.	Yield of cured leaves: Value Pesos	Total investment Pesos	Gain on investment Pesos
BROAD LEAF					
1, 7, 13 C'	0.0576	1535.961	337.911	262.80	75.111
2 H	0.0760	2026.616	445.855	280.80	165.055
3 HA	0.0685	1826.621	401.856	285.20	116.656
4 HC	0.0690	1839.954	404.789	285.20	119.589
5 HV	0.0705	1879.953	413.589	289.60	123.989
6 A	0.0505	1346.633	296.259	267.20	29.059
8 AC	0.0595	1586.627	349.057	271.60	77.451
9 AV	0.0702	1871.953	411.829	276.00	135.829
10 C	0.0680	1813.288	398.923	267.20	131.723
11 CV	0.0650	1733.290	381.323	276.00	105.323
12 V	0.0770	2053.282	451.722	271.60	180.122
ECHAGUE					
1, 7, 13 C'	0.0537	1431.964	315.032	262.80	52.232
2 H	0.0725	1933.285	425.322	280.80	144.522
3 HA	0.0654	1743.956	383.670	285.20	98.470
4 HC	0.0631	1682.624	370.177	285.20	84.977
5 HV	0.0653	1741.289	383.083	289.60	93.483
6 A	0.0525	1399.965	307.992	267.20	40.792
8 AC	0.0620	1653.292	363.724	271.60	92.124
9 AV	0.0530	1413.298	310.925	276.00	34.925
10 C	0.0585	1559.961	343.191	267.20	75.991
11 CV	0.0596	1589.293	349.644	276.00	73.644
12 V	0.0752	2005.283	441.161	271.60	169.562
ROMERO					
1, 7, 13 C'	0.0448	1194.636	262.819	262.80	0.019
2 H	0.0605	1613.293	354.924	280.80	74.124
3 HA	0.0503	1341.299	295.085	285.20	9.885
4 HC	0.0534	1423.964	313.272	285.20	28.072
5 HV	0.0486	1295.967	285.112	289.60	4.488
6 A	0.0435	1159.971	255.193	267.20	12.007
8 AC	0.0453	1207.969	265.753	271.60	5.847
9 AV	0.0465	1239.969	272.793	276.00	3.207
10 C	0.0472	1258.635	276.899	267.20	9.699
11 CV	0.0508	1354.632	298.019	276.00	22.019
12 V	0.0504	1343.966	295.672	271.60	24.072

NOTE: C' = Control. C = Compost. H = Horse manure. A = Ash V = Vines.

It will be seen from Table V that legume vines and horse manure produced the greatest effect on the yield of Broad Leaf and the Echague. Horse manure ranked first on the yield of Romero while legume vines ranked fifth. It was found that fertilizers such as ash, the combination of ash and compost, ash and vines, and horse manure and vines gave negative results on the yield of Romero.

The use of these fertilizers on this variety grown separately does not give even an income that will cover the total expenses of the operation, as is shown in Table III.

Ash, which gave the lowest result ranked the last in the yield of Broad Leaf and Echague. In some of its combinations it exercised a medium effect on the production of the same varieties. The marked differences between the effect of ash alone and those of some of its combinations on the yield of tobacco leaf can be accounted for if we examine Table III where it will appear that wherever any beneficial effect is noticed ash is always combined with nitrogenous fertilizers. Priego in his experiment found the opposite to be true. He reports that ash gave the most effective results both on the height and yield of the plants.

Compost alone and some of its combinations as shown in Table III ranks medium in effect of the yield of the three varieties of tobacco used. But where it was combined with horse manure it ranked second in Romero. Palafox in his work on fertilizer tests with tobacco varieties in the College soils in the year 1916 found that legume vines and horse manure gave the highest yield. Similar results with these fertilizers were obtained in this experiment.

BURNING QUALITY OF THE DIFFERENT VARIETIES OF TOBACCO

The burning quality of cured leaves of tobacco was tested in the following manner. Ten leaves from each variety in a plot were separated. A lighted cigar was touched on the surface of the leaves and the number of seconds of duration of glow was recorded. The average of ten records of the glow was taken as the final record of a single test for one variety.

Table IV gives the results of the test on the burning quality of the leaves of the different varieties of tobacco grown under treatment with different fertilizers.

TABLE IV.—*Effect of fertilizers on burning quality.*

Cul. No.	Kinds of Fertilizers.	Duration of Glow.		
		Broad Leaf	Echague	Romero
		Sec.	*Sec.*	*Sec.*
1, 7,13	Control	22.5	25.8	18.5
2	Horse manure	15.5	10.3	5.7
3	Horse manure + ash	34.5	29.8	18.4
4	Horse manure + compost	16.0	8.3	4.8
5	Horse manure + vines	18.2	21.4	17.8
6	Ash	38.4	41.7	35.5
8	Ash + compost	30.5	25.4	8.5
9	Ash + vines	32.3	26.5	11.5
10	Compost	10.0	5.5	3.8
11	Compost + vines	15.5	12.5	7.6
12	Vines	40.5	43.5	36.2

From Table IV it will be seen that vines and ash and a combination of horse manure and ash rank first, second and third, respectively, while compost alone is the least beneficial on the burning quality of the three varieties of tobacco used. Whatever fertilizers compost is mixed with, it seems likely to give shorter duration of glow. This can be noted in the case of combinations of compost and vines, compost and horse manure and compost and ash.

Conclusions

1. The production of tobacco in the Philippines can be improved both in the quantity and the quality of the cured leaves by the application of natural fertilizers.

2. Of the natural fertilizers used, legume vines and horse manure gave the highest yield on the varieties Broad Leaf and the Echague; in the case of Romero, horse manure gave the highest yield, while legume vines ranked fourth in effect. The three varieties grown when other fertilizers were used gave an intermediate result, that is, between legume vines and horse manure.

3. The burning quality of the leaves of the three varieties used was improved by legume vines and ash, while compost alone gave the least beneficial result. Other combinations of fertilizers exercised intermediate effects on the burning quality of the three varieties of tobacco used.

4. Natural fertilizers do not only serve as plant food materials, but they also supply humus that is often lacking in the light soil in which tobacco is grown.

Recommendation

In order to secure a desirable result both in the yield and the quality of the leaf of tobacco the growers should pay more attention to the kinds and application of manure to the tobacco plant.

Acknowledgement

The writer is indebted to Professor Charles Fuller Baker and Professor F. W. Ashton for their valuable suggestions and criticisms during the progress of the work.

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The Possibilities of Chewing Tobacco and Blended Cigarettes in the Philippines *

By Benedicto Leaño y Clamor

Tobacco growing in the Philippines is generally confined to the production of raw materials for local manufacture of cigars, cigarettes, and shredded tobacco, or *picadura*. A large quantity of this product is locally consumed but a considerable quantity is also exported. Of the total exported cigarettes for the year of 1917, Hongkong, Japan, China, Hawaii and United States obtained 83.45 per cent, and for the same year, United States, China, Spain, British East Indies and Hongkong obtained 93 per cent of the total export of cigars. Besides cigars and cigarettes we also export unmanufactured tobacco leaf. Despite this export there is a large and steadily increasing demand for plug tobacco and blended cigarettes in the Islands. These two articles are imported chiefly from the United States.

Table I compiled from the report of the Bureau of Customs for the year 1918, (1) shows the annual importation since 1913 of plug tobacco and cigarettes into the Philippines.

Table I.—*Annual importation of tobacco into the Philippines.*

Year.	Plug Tobacco.		Cigarettes.	
	Quantity.	Value.	Number.	Value.
	kg.			
1913	161,206	₱224,720	——	——
1914	175,132	249,872	8,614,622	₱93.522
1915	249,905	362,721	12,498,151	125,711
1916	253,375	368,681	13,871,390	148,623
1917	295,659	449,395	32,796,723	253,602
1918	323,123	503,145	59,150,000	460,246

The chewing tobacco type or the heavy type of tobacco required for the manufacture of plug tobacco may be characterized as having thick, heavy, gummy leaves, strong and containing a high percentage of nicotine. Some of the varieties under this type, when cured, possess a naturally sweet flavor, and are great absorbers of the sauce with which it is treated in the process of manufacture. The same type of tobacco, however, when grown on certain soils may possess a very different character.

There is no doubt that among the many varieties of tobacco found in the Philippines, there are some which possess the qualities of the heavy type most suitable for the manufacture of chewing, or plug tobacco. But no effort has been made, nor is any being put forth now, to isolate them from the other varieties used in the manufacture of cigars and cigarettes. It is a common practice when chewing tobacco is wanted, to select the dark, thick leaves from any of the varieties grown. The tobacco farmer depends entirely on chance and on the fertility of the soil as a means of obtaining the heavy leaves desired for chewing tobacco.

On account of the steadily growing trade in these two lines in the Philippines, any work tending to promote the development of the manufacture, and more particularly, the production locally of acclimatized exotic strains suitable for these purposes will undoubtedly be more than amply repaid by the results obtained. Such work would primarily be in the line of isolating a heavy type of tobacco among local varieties, and in the introduction of well-known varieties from other countries. The present work is a study of the possibilities of growing in the Philippines the chewing tobacco variety and cigarette tobacco type from the United States and China.

One Manila tobacco factory, the *B. B. B. y La Ideal*, manufactures on an extensive scale chewing tobacco known

*Thesis presented for graduation from the College of Agriculture, No. 74, Experiment Station Contribution No. 10.

in the Philippine market as *mascada*. In this factory the dark coarse strong leaves are especially in demand. The quality and shape of the chewing tobacco it turns out for sale are entirely different from the plug tobacco imported from the United States. This chewing tobacco is made by hand and is prepared in the same way as ordinary cigars except that the wrapper is cut into a rectangular shape and wound tightly around the bundle of fillers, without the binder. The cigar-like *mascadas* are made a uniform length of 10 centimeters by trimming off the ends. No special treatment is applied to the leaves, a practice common in the United States, to improve the quality and flavor of the finished product. The *mascadas* are of three sizes; they are packed in bundles of 6, 12, 20 and sold at ₱2.40, ₱1.80, ₱1.50 per kilogram, respectively. The Filipinos consume the *mascada* either by chewing it alone or mixed with *buyo* (betlenut). Many Filipino chewers prefer the imported plug tobacco to the native *mascada*, and one will find that even the smallest out-of-the-way tiendas sell this imported chewing tobacco.

Experiments and Results

SOURCES OF SEEDS

Seven varieties of imported heavy types of tobacco were used in this experiment. There are: 6664, Improved Gold Leaf; 6662, Judy's Pride; 7745, Kentucky Halley's White Burley; 7747, North Carolina Warne Tobacco; 7748, B. A. T. White Stem Orinoko; 7743, B. A. T. Gooch; 7746, B. A. T. Adcock. The number before each variety name is the record number in the accession book of the Department of Agronomy. The first four varieties came from the United States and the other from the British-American Tobacco Co., in China. All of the seeds were obtained through Mr. Walter E. Olsen, a well-known tobacco dealer in Manila.

CULTURE

On account of the irregularity of the arrival of the seeds, two plantings with almost a month's interval between were made. The Improved Gold Leaf and Judy's Pride were planted on September 22, 1917. The other five varieties were planted on October 21, 1917. The seeds were sown on rich soils in wooden flats made by cutting kerosene packing boxes into halves.

To prevent the occurrence of "damping off" the soil was moistened and then thoroughly sterilized by heating over a sheet of iron. On October 15, 1917 the seedlings of the first planting were pricked into framed commercial seed beds which had been well manured, and, on November 22, those of the second planting. The plants were set five centimeters apart.

Worms were daily picked off by hand. The seed beds were watered when the condition of the soil demanded it. The frame was covered with a strong white cloth (Catonia), which was rolled up for a short time in the morning every day to allow sunlight on the seed bed for a few hours.

It was rather unfortunate that at the beginning of the present experiments an outbreak of rinderpest occurred in the vicinity and the quarantine regulations enforced there, prevented the hauling of animal manure, the source of which lies within the infected district of Los Baños and the vicinity of the College of Agriculture. In consequence of these circumstances the work was confined mainly to acclimatization of the varieties.

The Improved Gold Leaf and Judy's Pride were transplanted into trial plots from November 17 to 19, 1917, the distance between plants being one meter

each way. For heavy tobacco a greater distance is necessary in order to obtain abundant sunlight and to gain more body and weight. Ten days after planting, when the roots were already firmly established, the soil was cultivated with a light hoe. Later, as the plants grew older the hand cultivator was used.

The late seedlings were transplanted on January 4 and 5, 1918. From the time of transplanting until harvest the plants were guarded against worms and grasshoppers, which were hand picked and smashed. Wilt disease attacked many of the plants and caused the death of a large number.

TOPPING AND SUCKERING

As soon as the flower buds appeared they were cut off. According to Scherffius and his co-workers (4), the grower should practice topping judiciously; a slow growing plant should not be topped as high as a rapid grower, since the former will not mature as many leaves as the latter. The same writers states that plants grown on poor soil should not be topped as high as those grown in rich ground. For topping plug tobacco, Moodie (5) recommends the removal of all but ten to twelve leaves, not counting the sand leaves.

The writer observed that the topped plants gave more body with thick, rough leaves than those that were allowed to bear flowers; these were pale green with light small bodies. This is due to the fact that in the topped plants the food materials that would have been used for the formation of seeds and unnecessary top leaves, were transferred to the leaves.

Topping is always followed by the marked development of lateral suckers; these suckers were nipped off as soon as they appeared. When suckers were overlooked and had grown to a large size a knife was used in their removal, thus avoiding injury to the plant.

After the first removal of the suckers from the axil of the upper leaves, suckers will develop from the axils of the middle leaves, and after those have been taken out, secondary suckers appear where the first were removed. For this reason suckering has to be done at intervals of from three to five days until the crop is ready for harvest.

DESCRIPTION OF LEAVES

The present culture was carried on under two extreme weather conditions. During the planting period and for some time thereafter there was continual hard rain; this was followed by dry weather until the time of harvest. As a result many of the plants died because of excessive dryness of the soil and atmosphere. There were, however, plants which in spite of the adverse conditions were able to attain normal development, and these enabled the writer to make the following description of varieties.[1]

6662, Judy's Pride.—The average length and breadth of the standard leaves of the average plant is 53.6 centimeters and 26.7 centimeters, respectively. The average length and breadth of the standard leaves of the best plant is 63.5 centimeters and 32.5 centimeters, respectively. The shape of the leaves is obovate with more or less acute apex; texture, gummy; thickness, coarse and heavy; color of leaves-yellowish green; veins, white; petiole, broadly winged; position of leaves, horizontal.

6664, Improved Gold Leaf.—The average length and breadth of the standard leaves of the average plant is 42.8 centimeters and 18.0 centimeters, respecti-

[1] Definition of terms used in the botanical description of each variety were taken from directions for note-taking for use in making field notes adopted by the Office of Plant Breeding Investigations of the United States Department of Agriculture.

vely. The average length and breadth of the standard leaves of the best plant is 54.2 centimeters and 22.5 centimeters, respectively. The shape of leaves is obovate with acute apex; texture, gummy thickness, medium coarse; veins coarse, color whitish green petiole, partly winged; position of leaves, horizontal.

7745, Kentucky Halley's White Burley.—The average length and breadth of the standard leaves of the average plant is 52.2 centimeters and 25.2 centimeters, respectively. The average length and breadth of the standard leaves of the best plant is 60.9 centimeters and 29.4 centimeters, respectively. The shape of leaves is obovate with acute apex; texture, gummy; thickness, coarse and heavy; color of leaves, yellowish green; surface of leaves, medium rough, and partly oily; veins, coarse, white color; petiole, broadly winged; position of leaves, partly pendant, tip almost touching the ground.

7745, B. A. T. Gooch.—The average length and breadth of the standard leaves of the average plant is 50.5 centimeters and 30.2 centimeters, respectively. The average length and breadth of the standard leaves of the best plant is 55.5 centimeters and 26.7 centimeters, respectively. The shape of leaves is obovate with obtuse, rather broad apex; texture, partly gummy; thickness, medium coarse; color of leaves, pale green; surface of leaves, coarse and oily; veins, medium coarse, dirty white color; petiole, broadly winged; position of leaves, horizontal.

7746, B. A. T. Adcock.—The average length and breadth of the standard leaves of the average plant is 51.0 centimeters and 24.5 centimeters, respectively. The average length and breadth of the standard leaves of the best plant is 55.5 centimeters and 26.7 centimeters, respectively. The shape of leave is obovate with obtuse apex; texture, somewhat gummy; thickness, medium; color of leaves, light green; surface of leaves, smooth, oily; under leaf surface, shiny; veins, coarse, light green color; petiole, partly winged; position of leaves, horizontal.

7747, North Carolina Warne Tobacco.—The average length and breadth of the standard leaves of the average plant is 41.5 centimeters and 19.4 centimeters, respectively. The average length and breadth of the standard leaves of the best plant is 44.0 centimeters and 21.2 centimeters, respectively. The shape of leaves is obovate with acute apex; texture, gummy; thickness, coarse and heavy; color of leaves, dark green; surface of leaves, rough and partly oily; veins, coarse, light green color; petiole, partly winged; position of leaves, horizontal.

7748, White Stem Orinoko.—The average length and breadth of the standard leaves of the average plant is 45.0 centimeters and 22.5 centimeters, respectively. The average length and breadth of the standard leaves of the best plant is 50.0 centimeters and 22.5 centimeters respectively. The shape of leaves is obovate with more or less acute apex; texture, gummy; thickness, medium; color of leaves, dark green; surface of leaves, medium rough; veins, coarse, greenish white in color; petiole, partly winged; position of leaves, horizontal.

TABLE II.—*Size of leaves of various varieties of tobacco.*

Variety.	Average plant		Best plant.	
	Length	Width.	Length.	Width
	cm.	*cm.*	*cm.*	*cm.*
Judy's Pride.....	53.6	26.7	63.5	32.5
White Burley.....	52.2	26.2	60.9	29.4
Improved Gold Leaf	42.8	18.0	54.2	22.5
B. A. T. Adcock....	51.0	24.5	55.5	26.7
B. A. T. Gooch.....	50.5	30.2	53.0	21.2
White Stem Orinoko	45.0	22.5	50.1	22.5
Warne Tobacco.....	41.5	19.4	44.0	21.2

Size of leaves.—It will be seen from Table II that the Judy's Pride and the White Burley lead the other varieties in the size of leaves of the exceptional plants and in the average size of twenty plants. The other varieties follow in the following order: Adcock, White Orinoko, Gooch, Improved Gold Leaf, and Warne Tobacco.

HARVESTING

The leaf by leaf method of harvesting was used in this experiment. The leaves were primed singly as they became fully matured and were carried to the curing house to be poled.

It is hard to give a safe and fast rule as to when the leaves are ready to be picked or primed. It takes experience to tell a ripe leaf at first sight. However, one will notice that when the leaf begins to ripen it changes its color from dark or pale green to a lighter shade and takes on a mottled appearance. The leaves become thick and leathery. The veins become brittle as may be tested by folding the leaf between the fingers. If the leaf is ripe it snaps and retains a crease where it was folded.

On February 4, 1918, the sand leaves of the Judy's Pride were harvested, and on the 15th of the same month the standard leaves of the same variety were harvested. The Improved Gold Leaf was harvested on March 15. The White Burley, Gooch, Orinoko, Warne, and Adcock were harvested, March 29, 1918.

The leaves were intentionally left on the plant to become fully matured to develop their natural fragrance and proper texture and to be thoroughly sweetened by nature. Judy's Pride matured earlier than the Improved Gold Leaf. Priming was always done in the afternoon from 3 to 5 o'clock. The primed leaves were then carried into the curing house where they were allowed to wilt in a pile until the following day when they were poled.

POLING AND CURING

The poles used varied from two to four centimeters in diameter and were one and a half meters in length. In poling, the leaves were taken one by one and, by the use of a big needle and a string which was tied at one end of the pole, were strung alternately face to face, so that they rode alternately on the poles. Madre de cacao, (*Gliricida sepium*) and Ipil-Ipil which have the habit of forming long and straight branches are very excellent and economical poles for this purpose. Two days after poling the leaves were wilted enough to be folded inward without breaking. This process is necessary to prevent undesirable curling of the leaves.

While the leaves were undergoing the yellowing process, the temperature as well as light and humidity of the room was carefully regulated by closing and opening the windows. On windy days the windows in the direction of the prevailing wind were closed while half of the opposite windows remained opened. The main object of this regulation was to secure slow and natural curing.

The leaves are said to be thoroughly cured when the laminae as well as the midrib and smaller veins are perfectly dry. It required twenty days to cure the sand leaves, and twenty-five for the standard leaves of the Judy's Pride. For sand and standard leaves of the Improved Gold Leaf it required twenty days for the sand leaves and twenty-five days for the standard leaves. The Orinoko, Warne, Gooch, Adcock required eighteen days for the sand leaves and twenty-three days for the standard leaves.

The leaves when in this condition were ready to be fermented.

FERMENTATION AND SORTING

The poles bearing the cured leaves were taken off the rack, carried outside the curing house in the late afternoon and the leaves were allowed to receive the moist breeze over night under a shade. This was necessary in order that the leaves would have sufficient amount of moisture to undergo fermentation properly. Early the next morning the leaves were moist and pliable and convenient to handle. Cured tobacco leaf in this condition is said to be in proper "case" or "order." The strung leaves were bunched close together at the middle of the string and the two ends were tied around the butts making a solid bundle, or "hand." These hands were put into a box lined with Manila paper, placing the butts toward the side. The bulk of leaves was pressed down tightly and a weight was put on top to maintain the compactness.

Every morning during the course of fermentation the hands of the tobacco leaves were taken out from the box. This was done to cool the leaves and to loosen them so the hands would not be so compact and the leaves would not stick together. In rebulking, the layers of the hands were interchanged in such a way that the hands on the top of the bulk one day went in the middle of the bulk and the bottom layer on the top and the middle layer at the bottom. In this way the hands received uniform treatment.

After a week's fermentation the leaves were sorted into wrapper and filler types. This was done by taking the leaves one by one from the string and spreading the web of the leaf carefully on the table. From the appearance of the leaf in this position the wrapper could easily be distinguished from the filler. The leaves displaying uniform color, free from tears or holes, having desirable shape and finer veins and grain, were classified as wrapper, and those that were rough and torn out and small leaves were classified as fillers.

The two grades were then made again into several hands and were repacked for further fermentation or aging.

In the proper method of aging the bales of wrapper leaves were not allowed to heat any further, so they were stored in a cool place, while the bales of fillers were allowed to heat themselves in a warm room. The former was ready for use after about three months, while the latter was not ready for at least six months.

The color of the Judy's Pride and the White Burley, a uniform fine light brown, did not undergo any change in fermentation.

The Improved Gold Leaf had brown, coarse and slightly elastic fermented leaves most suitable for filler purposes.

Gooch, Orinoko, and Warne had practically the same yellowish brown color, while the Adock had a pale yellowish brown color.

THE MAKING OF CHEWING TOBACCO

It may be of interest to describe here in connection with the present work the processes involved in the manufacture of chewing tobacco in the United States. Killebrew (7) pointed out that the manufacture of tobacco has been going on for centuries, and from the simple operation of taking out the midrib and putting it up into twists, the industry now employs the skilled labor and mechanical appliances for drying it by artificial heat, reordering it by steam, treating it with sauces, weighing, putting on the wrapper and compressing into plugs in various forms and sizes. The method of preparing chewing tobacco or *mascada* in the Philippines has already been briefly described in the introductory part of this paper.

Killebrew gives a rather detailed account of how chewing tobacco is made in a well-constructed factory. From his description it is evident that an expensive factory, equipped with a great deal of machinery is necessary. And it is clear that to manufacture plug tobacco locally grown we need to install machinery similar to that used in the United States. The probable cost of the equipment, including the building, would be many thousands of pesos. Mr. Olsen is authority for the statement that with the necessary accessories we can manufacture plug tobacco in the Philippines to supply the local demand, from the varieties grown by the writer.

BLENDING

By "blending," as the term is used in this paper, is meant the process of combining several varieties or types of cured leaves in different proportions, after they have been thoroughly aged and flavored with diluted solution of sugar and glycerine. Blending is done for the purpose of providing pleasant and mild smoke and maintaining uniformly the quality or aroma of tobacco. The brands *Omar, Fatima, Pall Mall, Lucky Strike, Piedmont,* etc., are cigarettes of this kind. These brands of cigarettes, universally known, command the highest prices in the market.

No cigarette factory in the Islands practices this method of preparing cigarettes. This may be accounted for by the lack of trained men to handle the work and the want of suitable types of tobacco for the purpose. This business requires technical skill to blend the cured leaves of the farmer into attractive cigarettes for the consumer.

The varieties of tobacco grown by the writer are those commonly used in the United States. Mr. Walter E. Olsen blended the varieties grown by the writer and reported favorable results.

The following directions for blending tobacco for cigarettes were kindly furnished by Mr. Olsen:

1. The tobacco leaves should be thoroughly aged.
2. When the leaves are ready, prepare a solution of sugar, glycerine and water according to the following formula: 2 lbs. sugar; 2 lbs. glycerine dissolved in 1 gallon of hot water for every 100 lbs. tobacco.
3. Dip the leaves in the solution.
4. Spread the leaves in the air to dry.
5. Shred the tobacco.
6. With the great number of possible combinations with the different number of grades or type of tobacco on hand, it is suggested that the *hit or miss* method of finding the combination be made.
7. Perform actual test by smoking each combination.
8. The one which suits the taste of the smoker is the right combination.

Of the varieties raised by the writer in connection with his experiments, Mr. Olsen found that a conbination of 50 per cent Judy's Pride leaves (first grade); 15 per cent Judy's Pride (second grade); 15 per cent White Burley; 10 per cent Warne; 5 per cent Orinoko; and 5 per cent Adcock produces a mild effect that almost equals the imported blended cigarettes. The percentage of each kind depends upon the character or quality of each variety. The *stronger* the character the less amount is needed in blending, and vice versa. It appears from Mr. Olsen's combination that the Judy's Pride possesses a milder quality than the other, and the Orinoko and the Adcock the strongest.

As a business policy, the formulae used by the manufacturers for their respective brands of cigarettes are kept secret.

With the machinery now in use in the cigarette factories in the Philippines, it would require only a few additional mechanical devices, to produce locally this so-called modern blended cigarette, on a commercial scale. These devices are the huge ovens for redrying or reconditioning the cured leaves turned out by the farmer; the cooling chambers; the live steam chamber; and the press power for *prizing*.

Conclusions

1. In spite of unfavorable climatic conditions obtaining when the present experiments were performed, the White Burley, Judy's Pride, and Improved Gold Leaf appear to grow well under the local conditions. The Orinoko, Adcock, Gooch, and Warne, when further acclimatized might possibly equal or surpass the three former varieties.

2. The color, aroma, size, and shape of leaves have been pronounced by American tobacco merchants, who saw the cured leaves at Mr. Olsen's office, to be precisely the same as those grown in the United States.

3. With the necessary equipment for its manufacture it is possible to use the varieties grown by the writer for chewing purposes or making into plug tobacco.

4. The possibilities of these varieties for smoking purposes are made certain by the fact that blended cigarettes of good quality have been made from them and tested by Mr. Olsen and others.

Recommendations

1. The writer recommends that the next planting be made on a well selected rich soil, to obtain the qualities necessary for chewing tobacco.

2. In the absence of this kind of soil, liberal application of manure will give beneficial results.

3. For cigarette purposes sandy loam soil is preferable.

4. This work should be tried in all important tobacco-growing districts in the Islands.

Acknowledgments

The writer wishes to express his obligations to Mr. Walter E. Olsen for having untiringly and patiently rendered help and encouragement to the writer in many ways, which alone made the present work possible. All the seeds used in the present experiments were secured through him, and his very valuable criticism and suggestions given freely and enthusiastically during the progress of this work, proved to be very helpful. Professor Charles F. Baker, Dean of this College, has also rendered much valuable assistance.

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College Notes and Alumni News

The student body of the College held a convention for the purpose of selecting the candidates who should represent the interests of the College in the Municipal Council of Los Baños.

Messrs. Leopoldo B. Uichanco and Francisco O. Santos have been appointed fellows of the University, and Francisco M. Fronda, Valente Villegas, and Anastacio L. Teodoro, pensionados from the College of Agriculture, to pursue advanced studies in the United States.

Prince Yugala of Siam and his retinue, accompanied by Major Perley and by Acting Chief de las Alas of the Executive Bureau, visited the College of Agriculture.

Political rallies attended by students and some faculty members were held at the College of Agriculture by Apolinar Barbaza, Nacionalista candidate for governor, Apolonio Carpena, Nacionalista, for representative, Juan Cailles, Democrata, for governor, and Juan Sumulong, for senator.

The work of surfacing the road extending from the College of Agriculture to the Forest School was continued during April and May. The funds for this work were furnished by the Bureau of Forestry. About 300 meters of the road remain unfinished, because of exhaustion of the funds. Professor Harold Cuzner, of the College of Agriculture, was in charge of this work.

Professor Edwin Leroy Driggs, of the College of Engineering, and his class in field work in surveying, spent the vacation period, April and May, at the College of Agriculture. Part of their time was given to surveying for a road that would pass through the Experiment Station farm and connect with the present road ending at the Forest School.

Miss Emma S. Yule, Assistant Professor of English, spent the summer vacation at Baguio.

Vice-governor Yeater, Director Marquardt of the Bureau of Education, and Director Fischer of the Bureau of Forestry recently made a trip to the summit of Mount Makiling.

The following appointments were made in April: Victor Sulit, Assistant in Chemistry; German Yap, Assistant in Plant Physiology; Fernando de Peralta, Assistant in Plant Physiology; Tranquilino Ventura, Assistant in Chemistry; Francisco R. Red, Assistant in Agronomy; Francisco M. Fronda, Assistant in Animal Husbandry; Emillano Roldan, Assistant in Plant Pathology; Deogracias Villadolid, Assistant in Chemistry.

Dr. José S. Villacorta, College Physician, resigned April 16, 1919, to practice medicine in Manila.

During the month of May, Antonio Chanco was appointed temporary Assistant in Agronomy; Ramon V. Manio, Assistant in Agronomy, resigned; Sotero F. Albano, Assistant in Agronomy, was transferred to the Bureau of Agriculture.

The following appointments are to take effect in June: Mr. Evett D. Hester, A. B., Northwestern University, 1914, recently principal of the Union High School, has been appointed Associate Professor of Economics at this College. Mr. Hester has had wide service in the Islands, having seen service with the Bureau of Education in Cebu, Misamis, and Union province. Mrs. Grace L. Zschokke has been appointed Temporary Instructor in English. Dr. Sixto A. Francisco, '17, University of Illinois, until recently acting chief of the Baguio Hospital, has been appointed Resident Physician at the College of Agriculture. Mr. Manuel A. Roa, formerly connected with the University High School, has been appointed Instructor in Mathematics; Esteban Collado, Assistant in Chemistry; Francisco P. Lago, Assistant in Animal Husbandry; Juan P. Torres, Assistant in Economics; Pedro

David, Assistant in Agronomy; Ramon K. Habaluyas, Assistant in Mathematics; Raymundo Sabado, Assistant in Agronomy; Serapio Palafox, Drill Sergeant—formerly First Lieutenant in the Philippine National Guard.

Mr. Faustino Q. Otanes was transferred to the Department of Entomology, and has since been appointed pensionado from the Bureau of Agriculture, to take advanced studies in the United States.

Prof. B. M. Gonzalez, who spent six weeks of the Summer in a visit to the government cattle ranches in Mindanao-Sulu, visited the herds in the provinces of Lanao, Bukidnon, Cotabato, Jolo, and Zamboanga. He reports excellent work being done by our graduates doing agricultural advisory work in the different provinces.

Deputy-Governor Mariano E. Gutierrez, '17, was married to Miss Rosario de la Cruz of Cotabato May 1, 1919.

Mr. Jose M. Trinidad, Assistant Agricultural Advisor for the Department of Mindanao-Sulu is the proud father of a baby boy presented to him by Mrs. Trinidad in May.

Mr. Melecio M. Manio, '17, is stationed at Dansalan, Lanao, as assistant agricultural advisor for the province.

The College herd is now entirely free from the foot-and-mouth disease infection which is supposed to have been carried by the wild deer coming in contact with the cattle on the ranges. Strict quarantine and treatment were observed. There were no casualties, and most of the animals were able to work at the end of three weeks. One particularly interesting incident is that none of the native goats in contact with the sick cattle contracted the disease, although the goat is supposed to be susceptible.

Mr. Domingo B. Paguirigan, graduate of the College of Agriculture, until recently with the Bureau of Internal Revenue, has been appointed pensionado from the Bureau of Agriculture, to study tobacco in the United States.

Twenty-five new students, most of them High School graduates, entered the College in April. The attendance during the summer season, April and May, was one-hundred and ninety-four students.

In the meeting of the Alumni of the University of the Philippines held on April 4, Dr. Nemesio B. Mendiola, '15, was elected President.

The Annual meeting of the College of Agriculture Alumni Association was held in "La Campana" on the evening before Commencement Day. A banquet was held, and Mr. Fidel Reyes, Acting Director of the Bureau of Commerce and Industry, was the guest of honor. Election of Officers was the secondary feature of the evening, and the following were elected:

President . . . Inocencio Elayda
Treasurer . . Bienvenido Gonzalez
Secretary . . . Leopoldo Clemente

Dr. Nemesio B. Mendiola, '15, was married to Miss Filomena Alvarez, sister of Governor Agustin Alvarez of Zamboanga. The ceremony was held in Santa Cruz Church on May 24, 1919, and after it the visitors were offered a breakfast at "La Campana" by the "padrinos". The honeymoon was spent in Sibul Springs.

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The College year will begin June 9, 1919.

For further information address the Dean of the College.

INDEX

VOLUME VII

AUGUST, 1918 TO MAY, 1919

A

Adriano, Alfredo P., notes on 32, 230
Adriano, Felipe T., notes on 267
Agricultural congress 55; graduates 101-2, 103-5
Agriculture, importance of climatology to tropical 191-4
Agriculturists, technical, as government officials 106-7; meeting of technical 55, 230
Agromyza destructor 2-31; in India 2; phaseoli, in Australia 2; simplex 2; sojae 2
Agronomy seminar, notes on 184
Aguinaldo, General Emilio, notes on 55
Albano, Sotero F., notes on 322
Alcasid, Ezequiel E., growth and egg production of ducks as affected by feeding rice and corn 255-66; notes on 184, 267
Aldaba, Vicente C., cultivation and tapping of Castilloa rubber in the Philippines 274-307
Algue, Father Jose, notes on 184
Alincastra, Cecilio, notes on 154
Allarey, Vicente F., notes on 55
Alumni; agricultural 101-2; Association, College of Agriculture 96-7, College of Agriculture in its relation to 95; College graduates in the provinces 157-8; College meeting of 323; College and 55, 92, 122, 184, 230, 267; concerted action by 98; directory of College of Agriculture graduates 112-15; Philippine agricultural graduates as farmers 103-5; reading course 108-11; technical agriculturists as government officials 106-7; University, meeting of 323
Anas bosca, wild duck 255
Animals; Indian dairy buffalo, notes on 122; *see also* chicken, capon, duck, hog
Arana, Joaquin Ruiz, notes on 230
Ashton, F. W., notes on 32, 122

B

Baker, Charles Fuller, College of Agriculture in its relation to its alumni 95; notes on 55, 92, 154; post-graduate reading course for the alumni of the College of Agriculture 108-11
Banks, Charles S., book review 57
Barbaza, Apolinar, notes on 322
Bautista, Basilio R., notes on 230; production of grain and stalks by maize as affected by intercropping with legumes 36-43
Bautista, Pantaleon, experiments on hog feeding with and without pasture 72-83
Bayla, Arsenio M., hybridization of eggplants 66-71
Bean fly, Agromyza destructor 2-31
Bucoy, Alejandro, notes on 122
Buildings, new 185, 268

C

Cabanos, Juan B., notes on 267
Cagurangan, Alfonso B., notes on 122
Cailles, Juan, notes on 322
Cajanus indicus, caguios 9
Camoting cahoy *see* cassava
Canavalia ensiformis 9
Capistrano, Severo M., notes on 55, 122
Capons as brooders 254
Carpena, Apolonio, notes on 322
Cassava, Manihot utilissima 87
Centrosema plumieri 9
Cevallos, Felipe O., notes on 55
Chanco, Antonio, notes on 267, 322
Chickens, comparative study of native and Cantonese 137-47; egg production 239; effect of animal and plant protein in rations of laying hens 235-52; in the Philippines 233-4
Cigarettes, blended, possibilities of, in the Philippines 314-21
Clariza, Pedro, notes on 184
Clemente, Leopoldo, notes on 323
Climate; relation of climatic conditions to the vegetative growth and seed production of rice 159-79; *see also* weather observations
Climatology, importance of, to tropical agriculture 191-4
Cocannouer, Joseph A., notes on 184, 230
Collado, Esteban, notes on 267, 322
College of Agriculture; alumni association 96-7; College and Alumni notes 55, 92, 122, 184-5, 230, 267-8; facts about 116; honor roll 119-21; new tractor 268; and the Philippine National Guard 117-18; in its relation to its alumni 95; work of graduates in the Bureau of Agriculture 99-100
College of Veterinary Science, notes on 268
Corrales, Jose, notes on 122
Corticium salmonicolor, citrus disease 55
Cruz, Florentino F., experiments on the effect of certain Philippine feeds on the growth and production of eggs and meat by poultry 44-54
Cuzner, H., notes on 322
Cyamopsis psoralesoides, guar 9

D

Dario, Leoncio, notes on 267
David, Pedro, notes on 267, 322
Delgado, Felipe, notes on 154

Diseases and pests; asparagus 2; bean 2-31; citrus 55; cowpea 2; foot and mouth disease 323; rice 151; rubber 281; tobacco 309
Driggs, Edwin Leroy, notes on 322
Duck, Anas bosca, 255; growth and production of eggs 255-66, 233-4

E

Editorial; Agricultural Congress 55; College students in the provinces 157-8; College of Agriculture 93; Experiment Station 125-6; *Philippine Agriculturist* 1; planning, interpretation and presentation of research 271-3; poultry in the Philippines 233-4; Professor Gonzalez, new member of the Board of Regents 63.
Eggplants, hybridization of 66-71
Eggs; effect of certain Philippine feeds upon production 44-55; fertility 243, 263; production 239, 255-66; preservation 195-229
Elayda, Inocencio, agricultural graduates in their relation to the general farming public 101-2; notes on 32, 55, 154, 230, 323
Erese, Valentin, notes on 122
Esguerra, Jose, notes on 267
Estevanez, Victoriano J., notes on 92
Experiment Station, editorial 125-6
Exposition, announcement 95; notes on 92

F

Farinas, Basilio, notes on 55
Feeding stuffs, animal and plant proteins, 235-52; coconut 87; cassava 87; effect of Philippine feeds upon the production of eggs 44-54; kiapo 87; Pongapong 87; rice and corn 255-66
Fertilizers, effect of natural on the production of tobacco 308-13
Fischer, Director A. F., notes on 322
Forestry, road 322
Francisco, Sixto A, notes on 322
Fronda, Francisco M., capons as brooders 254; effect of animal and plant proteins in the rations of laying hens 35-52; notes on 267, 322

G

Gillis, C. R., notes on 32, 185, 230
Gillis, James R., notes on 185
Glycine hispida, soy bean 9
Goco, Arsenio A., notes on 55, 184
Gonzalez, B. M., College of Agriculture alumni association 96-7; notes on 55, 63, 92, 184, 230, 268, 323
Gonzalez, Joaquin J., notes on 267
Gonzalez, Mrs. B. M., notes on 32
Guar 9
Guard, Philippine National; notes on 122; Vets get credit 267; College of Agriculture and 117
Gutierrez, Mariano E., notes on 323; technical agriculturist as a Government official in Mindanao 106-7

H

Habaluyas, Juan, notes on 267
Habaluyas, Roman K., notes on 122, 323
Hamilton, Charles W., notes on 55
Harder, Tomas, notes on 267
Hernandez, Nemesio M., effect of natural fertilizers on the production of tobacco 308-13; notes on 267
Hester, Evett D., notes on 322
Hidalgo, Vicente F., notes on 267
Hog, feeding with and without pasture 72-83; industry in the Philippines 84-90; Jalajala 85-6

J

Jacobson, O. H., work of 65
Jugo, Rafael, notes on 122

K

Kalaw, Miss Manuela, notes on 32
Kenward, Hazel, notes on 184
Kiapo, Pistia stratiotes 87

L

Lago, Francisco P., notes on 267, 322
Lapie, Miss Dionisia, notes on 32
Leaño, Benedicto C., notes on 267
Leptocorisa acuta, atangia, rice pest 151
Lindayag, Gaspar, notes on 268
Lipayon, Anastasio, notes on 267
Livingston, Burton Edward, work of 272-3

M

Macasaet, Emilio B., notes on 122
Maceda, Felix N., notes on 122
Maize, production of grain and stalk, affected by intercropping with legumes 36
Malloch, J. R., work of 11
Manalang, Elias, notes on 230
Manihot utilissima, cassava 87
Manio, Melecio M., notes on 122, 268, 323
Manio, Ramon V., notes on 322
Manipol, Felix, notes on 55
Manzanilla, Miss Aurelia, notes on 32
Mariano, Jose, preservation of eggs 195-229
Marquardt, Director, notes on 322
Marquez, Francisco D., notes on 92, 230
McLean, Forman T., importance of climatology to tropical agriculture 191-4; notes on 92-268; weather reports 58, 59, 60, 61, 62, 91, 123, 155, 186-90, 231, 269
Meat, effect of certain Philippine feeds upon prodction of 268

Medalla, Mariano, notes on 32
Mendiola, Nemesio B., an inhibitor in rice 65; concerted action by the alumni 98; note; on 55, 92, 184, 230, 323
Mendoza, Jose M., notes on 55, 122
Merino, Gonzalo F., notes on 32, 92
Merrill, E. D., work of 57
Mirasol, Jose J., notes on 32; spacing experiments with sugar cane 127-56

N

Narabal, Tiburcio B., notes on 268
Navarro, Andres, notes on 92
Nisce, Teofilo A., notes on 268
Noguera, Jose, hog industry of the Philippines 84-90; notes on 268

O

Otanes, Faustino Q., bean fly 2-31; notes on 323

P

Padolina, Felipe, notes on 268
Paguirigan, Domingo B, notes on 122, 184, 323
Palafox, Serapio, notes on 55, 122, 323
Paliat, coconut-meal cake 87
Patrimonio, Ceferino, notes on 230
Peralta, Fernando de, notes on 268,322; relation of climatic condition to the vegetative growth and the seed production of rice 159-79
Perkins, G. A., notes on 230
Pests *see* diseases and pests
Phaseolus lunatus, lima bean 6; vulgaris 3
Pineapple 32
Pistia stratiotes, kiapo 87
Pongapong, Amorphophallus campanulatus 87
Poultry, production of eggs and meat 44-54; effect of animal and plant proteins in rations for laying hens 235-52; in the Philippines, editorial 233
Psophocarpus tetragonolobus, calamismis 9

Q

Quisumbing, Francisco, notes on 32

R

Ramos, Primitivo, notes on 32, 92, 154
Red Cross, notes on 32,154
Red, Francisco, notes on 122, 268, 322
Reinking, Otto A., notes on 268
Reyes, Simon A., notes on 184
Rice, an inhibitor in 65, elite culture and multiplication 149-53; harvesting 170; methods of sowing 160; pests and diseases 151; preparation of paddies 150; relation of climatic conditions to 159-79; transplanting 163
Roa, Manuel A., notes on 322
Road, College Farm, notes on 185
Roldan, Emiliano, notes on 268, 322
Romero, Leon M., elite culture and multiplication of some standard Ilocano and Tagalog lowland rices 149-53
Romero, Vicente, notes on 55
Roxas, Manuel L., notes on 32, 92, 230, 268
Roxas, Mrs. Manuel L., notes on 32
Rubber, Castilloa, cultivation and tapping of, in the Philippines 274-307; leaf 283 pests and diseases 281;

S

Sabado, Raymundo, notes on 268, 323
Sablan, Eladio, notes on 184
Salary increase in the Department of Agriculture 267
Salcedo, Improgo, notes on 154
Santos, Francisco O., notes on 267, 322
Sanvictores, Jose, notes on 55, 184; survey of the work of the graduates of the College of Agriculture in the Bureau of Agriculture 99-100
Sarao, Felix B., notes on 184
Schoenobius incertellus, rice stem-borer 151
Scholarships, rules for 92, 184; notes on 230
Serrano, Felicisimo, notes on 268
Soil; tobacco, preparation of 308; rice, preparation of 150
Stizolobium lyoni, velvet bean 9
Students, number in summer session 323
Sugar cane, spacing experiments 127-36
Sulit, Victor, notes on 268, 322
Sumulong, Juan, notes on 322
Swingle, Mrs. W. T., notes on 32
Swingle, W. T., notes on 32

T

Teodoro, Anastacio L., notes on 268, 322
Teodoro, Nicanor G., notes on 55, 184
Tobacco, blending 320; chewing, making of 319-20; chewing, possibilities of in Philippines 314-21; fertilizers, effect of on production 308-13; harvesting 310, 318; pests and diseases 309; poling and curing 310,318
Torres, Juan P., notes on 322
Trelease, S. F., notes on 92; planning, interpretation and presentation of research 271-3
Trinidad, Jose M., notes on 55, 122, 323

U

Uichanco, Leopoldo B., notes on 92, 322

V

Velasquez, Baldomero T., notes on 122
Ventura, Tranquilino notes on 267, 322
Vibar, Toribio N., notes on 55, 92
Vigna sinensis, cowpea 2, 3, 4
Villacorta, Jose, notes on 122, 322

Villadolid, Deogracias, notes on 122, 268, 322
Villegas, Miss Ursula, notes on 32
Villegas, Valente, notes on 322

W

Weather observations; March 1918, 58; April 1918, 59; May 1918, 60; June 1918, 61; July 1918, 62; August 1918, 91; September 1918, 123; October 1918, 155; November 1917, 186; January 1918, 187; February 1918, 188; November 1918, 189; December 1918, 190; January 1919, 231; February 1919, 269
Weston, W. H., notes on 184

Y

Yangco, Teodoro R., notes on 185
Yango, Clemente, notes on 122
Yap, German, notes on 122, 268, 322
Yeater, Vice-Governor, notes on 322
Yñiguez, Alfredo V., notes on 230
Yugala, Prince of Siam, notes on 322
Yule, Emma S., notes on 230, 322; post-graduate reading course for alumni of the College of Agriculture 108-11

Z

Zamora, Jose, Philippine agricultural graduate as an independent farmer 103-5
Zschokke, Grace L., notes on 322

ACKNOWLEDGMENT

This index was compiled by Hazel Kenward, associate professor of chemistry in the College of Agriculture.

The staff of the *Philippine Agriculturist* hereby expresses its appreciation of this exacting and valuable work.

The EDITORS

THE PHILIPPINE AGRICULTURIST

Vol. VII AUGUST, 1918 No. 1

IMP. BUR.
11 NOV. 1918
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CONTENTS

	Page
Editorial	1
The Bean Fly (with five plates)	2
College and Alumni Notes	32
Obituary: Lucio Antonio San Miguel	33

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Vol. VII SEPTEMBER, 1918 No. 2

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12 DEC. 1918
ENTOM.

CONTENTS

	Page
Frontispiece	
Editorial	35
The Production of Grain and Stalks by Maize as Affected by Intercropping with Legumes	36
Experiments on the Effect of Certain Philippine Feeds on Growth and Production of Eggs and Meat by Poultry	44
College and Alumni Notes	55
Book Review	57
Weather Observations	58

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Vol. VII OCTOBER, 1918 No. 3

IMP. BUR.
12 DEC. 1918
BOTOM.

CONTENTS

	Page
Frontispiece	
Editorial	63
An Inhibitor in Rice	65
Hybridization of Eggplants	66
Experiments on Hog Feeding with and without Pasture	72
The Hog Industry of the Philippines with Special Attention to the Provinces around Manila	84
Weather Observations	91
College and Alumni Notes	92

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Vol. VII NOVEMBER, 1918 No. 4

ALUMNI NUMBER

CONTENTS

	Page
Frontispiece	
Editorial	93
The College of Agriculture in its Relation to the Alumni	95
An Announcement	95
The College of Agriculture Alumni Association	96
Obituary: Eusebio Toloza	97
Concerted Action by the Alumni	98
A Brief Survey of the Work of the Graduates of the College of Agriculture in the Bureau of Agriculture	99
The Agricultural Graduates in their Relation to the General Farming Public	101
The Philippine Agricultural Graduate as an Independent Farmer	103
The Technical Agriculturist as a Government Official in the Department of Mindanao and Sulu—His Mission and Opportunities	106
Obituary: Baldomero T. Velasquez	107
A Postgraduate Reading Course for Alumni of the College of Agriculture	108
A Directory of the Graduates of the College of Agriculture	112
Facts about the College	116
The College of Agriculture and the Philippine National Guard	117
Honor Roll	119
College and Alumni Notes	122
Weather Observations	123

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THE PHILIPPINE AGRICULTURIST

Vol. VII DECEMBER, 1918 No. 5

CONTENTS

	Page
Editorial	125
Spacing Experiments with Sugar Cane	127
A Comparative Study of Cantonese and Native Chickens	137
Élite Culture and Multiplication of Some Standard Ilocano and Tagalog Rices	149
College and Alumni Notes	154
Weather Observations	155
To Our Readers	156

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Vol. VII JANUARY, 1919 No. 6

CONTENTS

Page

Frontispiece

Editorial - - - - - - - - - - - - - - - - 157

A Study of the Relation of Climatic Conditions to the Vegetative Growth and Seed Production of Rice - - - - - - - - - - - - - - - 159

College and Alumni Notes - - - - - - - - - 184

Weather Observations - - - - - - - - - - 186

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The College year will begin June 9, 1919.

For further information address the Dean of the College.

THE PHILIPPINE AGRICULTURIST

Vol. VII FEBRUARY, 1919 No. 7

CONTENTS

	Page
Frontispiece	
The Importance of Climatology to Tropical Agriculture	191
The Preservation of Eggs	195
College and Alumni Notes	230
Weather Observations	231

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THE PHILIPPINE AGRICULTURIST

Vol. VII MARCH, 1919 No. 8

CONTENTS

	Page
Editorial	233
A Study of the Effects of Animal and Plant Proteins in Rations for Laying Hens	235
Capons as Brooders (One Plate)	253
The Growth and Egg Production of Ducks as Affected by Feeding Rice and Corn	255
College and Alumni Notes	267
Weather Observations	269

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THE PHILIPPINE AGRICULTURIST

Vol. VII APRIL - MAY, 1919 No. 9 - 10

CONTENTS

	Page
Editorial	271
Cultivation and Tapping of Castilloa Rubber in the Philippines	274
The Effect of Natural Fertilizers on the Production of Tobacco	308
The Possibilities of Chewing Tobacco and Blended Cigarettes in the Philippines	314
College and Alumni Notes	322

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